THE LAWS OF HEALTH

A HAND-BOOK ON
SCHOOL HYGIENE

BY

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PREFACE

One of the most striking features of primary education at the present time is the keen and practical interest taken in the physical and hygienic aspects of school life. Educational authorities in every civilized country are awake to-day to the supreme importance of caring for the bodily health of the child, and of bringing his environment into line with modern hygienic knowledge, while the mind is being trained to think and the brain stored with facts. Everyone who has the education of young children seriously at heart rejoices that this is so, and it has come to be recognized that one of the most powerful and practical means of ensuring success in this matter, is to train the teachers before they enter upon the serious duties of their profession.

Systematic courses of instruction for teachers in elementary anatomy, physiology, and hygiene have accordingly been mapped out by various educational authorities, and in Scotland lectureships on the laws of health have been established in connection with the university training of teachers. In my own case the instruction given consists in part of systematic lectures, and in part of practical work at various schools, where the members of the class, in suitable small sections, study the structure of schools, methods of heating, lighting, and ventilation, floor area and cubic space, arrangement of desks and seats, and so forth. They learn how to weigh and measure children, how to detect errors in vision by simple means,

and how to discriminate between the weakly and underfed, and those who are fit for ordinary school-work, exercises, and games. It has been felt that a small text-book would be a great help as a supplement to the lectures, and I therefore issue this manual in the hope that it may prove of service not only to teachers in training, but to those also who are now regularly engaged in the teaching of the young.

Some may object that the sections dealing with anatomy and physiology are too short. This abbreviation is intentional. There are already excellent small manuals dealing with physiology suitable for the teacher's needs, and what is wanted is a book treating of the application of physiological knowledge to the hygiene of school life. The tendency in lectures on the laws of health is to overburden them with purely anatomical and physiological details, and so obscure their real purpose and lessen their value.

In the original preparation of my lectures, I gained many useful hints from the excellent articles on the teaching of hygiene to teachers, which appeared in the *British Medical Journal* during 1904–1905. Use has been made of them once more in preparing this manual. Most of the illustrations have been furnished by my publishers. For No. 16 I am indebted to Messrs. E. & S. Livingstone, and for Nos. 44 and 45 to Messrs. Cassell & Co. The drawings for Nos. 59, 64, and 68 were done by Mr. W. Douglas Lockhart. The source of any others is acknowledged in the text.

C. C. D.

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CONTENTS

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

CHAPTER XV

THE LAWS OF HEALTH

CHAPTER I

Introductory—The Necessity of having a Correct Knowledge of the Laws of Health—The Elementary Anatomy and Physiology of the Circulation and Respiration.

Hygiene may be regarded as the science and art of preserving health and prolonging life. It deals with the individual in the domain of personal health (and it is with this that we shall be specially concerned), while it treats also of the health of communities—in the village, the town, and the state,—and this we term Public Health or State Medicine.

When we discuss the Laws of Health we are treating of certain rules or laws of nature which have been defined as formulæ that express correctly the invariable order in which facts occur. If we learn these formulæ or laws, and if we (and those under our care) conform to them, we shall enjoy better health, better power to work, greater enjoyment in leisure, and the prospect of increased longevity. If we neglect or break them, we shall be punished in that slow though sure fashion in which Nature deals with those who despise her laws.

It may be asked by some, Why should teachers or those about to become teachers concern themselves so much with this question of health in school life, and its principles? the duty of the teacher, it may be said, is to develop and train the mind. The answer to the question is simply this, that we cannot, even if we would, divorce the care of the body from that of the mind, and among young children especially it is the former that demands the greater care and attention. The

sound mind in the sound body is a phrase so hackneyed that one hesitates to repeat it again, but whether we use it or not, its intrinsic truth is daily being forced upon us. Whatever be our views on purely metaphysical questions, everything drives the conviction home to us that the brain is the organ of mind, and that its countless nerve-cells and nerve-fibres form the physical basis of mental activity. Its parts, as long as life continues, are in a constant state of flux, and in no individual more than in the growing child, continuously undergoing waste and repair, growth and alteration.

Now for the healthy action and satisfactory growth of this organ it must have a reasonable supply of nourishment, and in the pages that follow we shall discuss the different kinds of food-stuffs, how they are digested, absorbed, and used in the body; the heart and circulation, by means of which blood, laden with food and the vivifying gas oxygen, is taken to all parts; and the function of respiration, by which we take in oxygen to the body. The teacher must also have some knowledge of the framework of the body—the bones, joints, and muscles, and how these are benefited by exercises, and hurt by bad postures and insufficient or wrong feeding. The waste of the body is got rid of by various channels, among them the skin, and we cannot have healthy children with dirty skins. The skin, too, helps to keep the temperature of the body steady, and must be clothed, so that a few words will need to be said regarding children's garments and the materials most suitable for them. Those points all concern the ordinary child, but there are many matters connected with unhealthy children of which the school-teacher of to-day must have some knowledge. There are the various infectious illnesses, which cause so much absence; the minor ailments of child life, which worry and distress the child; the affections of the eyes and throat, which hamper sight and hearing, and so on. Then there are the poorly-developed bodies, so ready to become deformed, the flat or contracted chest, the curved legs, the bent spine, the rounded shoulders,—all these the teachers in poor parts of large cities will have ample opportunity of

seeing, and they are conditions that can be greatly improved during school life. By prevention they can be kept from getting worse, and by suitable physical exercises they can be greatly improved and even cured. It is not for a moment suggested that teachers are to be doctors, but they often have to deal with children of the poorest classes whose parents are too ignorant or indifferent or hard-pressed in the struggle for life to give much thought to their children's health. Teachers have many opportunities of seeing early indications of defective health, and it is part of the object of the modern teaching in school hygiene to make teachers capable of observing these warning signs. Having observed them, it may be possible by notification in the proper quarter—to the headmaster, parents, or medical officer of the school—to render the child an invaluable service, and to deserve the gratitude of the State for safeguarding and improving the health of the future citizen.

Happy results of this kind are attained, not by the use of drugs, but by careful attention to the environment of the child—the air-space, sunlight, and so forth at its disposal; its clothing, food, and personal cleanliness; and by a systematic use, short of fatigue, of well-planned, graded physical exercises.

It is now widely recognized that the scholar as well as the teacher should learn something of the elements of hygiene, though it is somewhat humiliating to our pride to reflect that Great Britain has by no means been in the forefront in this subject. Our colonies have shown much greater enterprise in this matter. In Victoria, South Australia, New South Wales, Natal, and Canada, hygiene is taught, and in most is made a compulsory subject in all public elementary schools. In America and Sweden the teaching of hygiene is made obligatory—in the former by education laws, in the latter by Act of Parliament. In Denmark, Holland, and Italy it is also taught.

With this introduction we may proceed to study the subject in detail, and may suitably concern ourselves, first, with a survey of the circulation of the blood, and with the function

of respiration, as these lead us naturally to the subject of ventilation—one of primary importance in school hygiene.

The Circulation of the Blood

The blood circulates through the body by means of (*a*) the heart acting as a pumping engine, and (*b*) the blood-vessels serving as pipes. These blood-vessels are of two kinds—*arteries* and *veins*. An artery is a vessel which carries blood from the heart, and in nearly all instances the blood in arteries is pure. A vein is a vessel which conveys blood to the heart, and in practically all instances the blood is of impure quality. As an artery proceeds from the heart it gives off branches and grows smaller in calibre, terminating at length in a net-work of fine hair-like thin-walled tubes of much delicacy called *capillaries*. These in their turn coalesce into larger twigs, and these uniting form the beginning of a vein, which grows in size as it progresses towards the heart. As an artery gives off branches, so a vein receives tributaries on its way. A small artery is sometimes termed an *arteriole*, a small vein a *venule*.

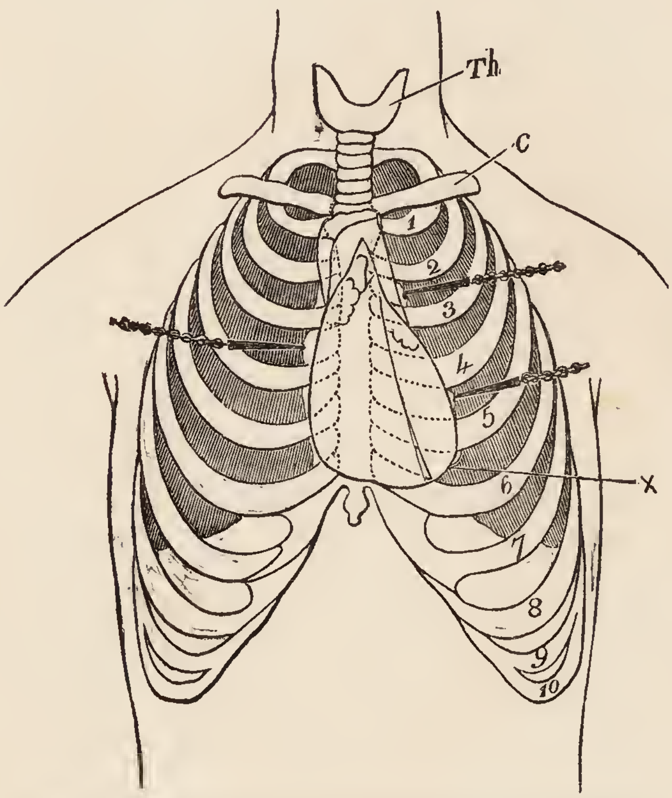


Fig. 1.—The Position of the Heart and Lungs

The lungs are represented shaded and drawn aside by hooks to show the extent of the heart, which is mapped out by continuous lines. *c* shows the position of the collar-bone, and 1, 2, 3, &c., indicate the ribs. The outline of the breast-bone and ribs in dotted lines marks the parts that would require to be removed to expose the heart fully in the body. X points to the apex of the heart, occupying a position between the fifth and sixth ribs. *Th.* is the thyroid gland.

The Heart.—The heart lies in the front of the chest, chiefly on the left side. It lies mainly behind the third, fourth, and fifth ribs on the left side (fig. 1). In shape it is somewhat like a large rounded pear, situated obliquely in the chest, its upper thick end (termed the base) being behind the upper part of the breast-bone. The point is directed downwards and outwards and to the left, and is opposite a point on the chest-wall situated between the fifth and sixth ribs, and about three inches to the left side of the breast-bone. This lower end of the heart is known as the apex (fig. 1). The ancients were well acquainted with the position of the heart, and when we read in the Scriptures "he struck him under the fifth rib", we can understand what deadly effect a stroke upwards in this part of the chest would have. It is a strong muscular organ, well fitted for its important and unceasing labours, sometimes carried on for a hundred years. In the lifetime of a centenarian this organ gives over 3,000,000,000 beats.

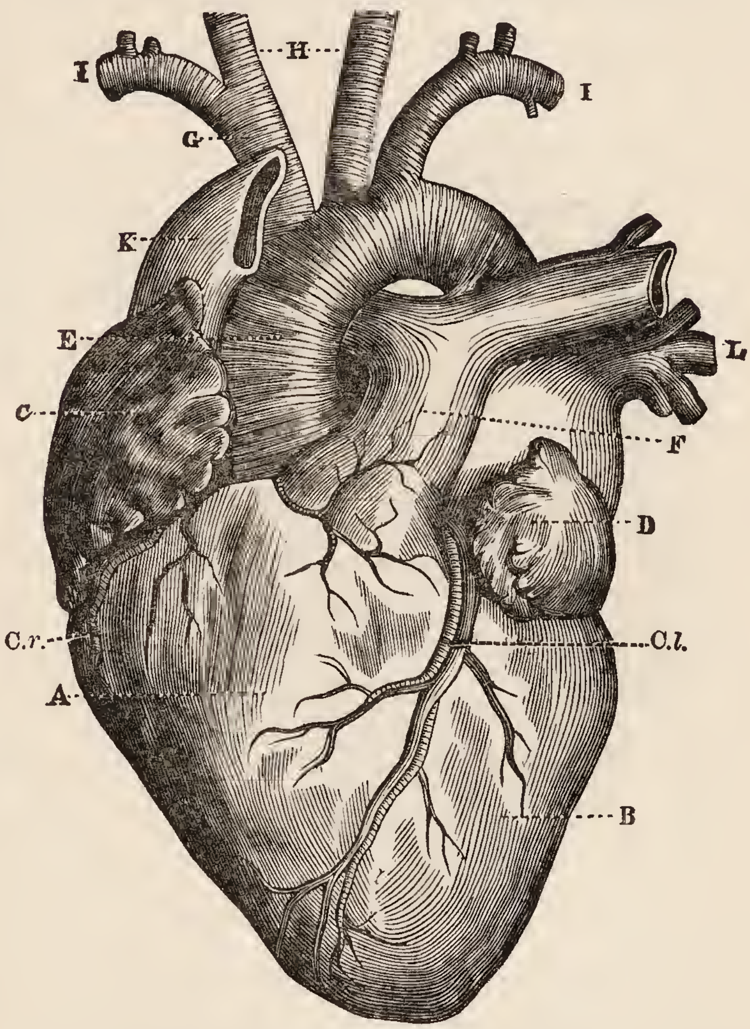


Fig. 2.—The Heart

A and B, Right and left ventricles; C and D, right and left auricles; E, aorta; F, pulmonary artery; G, innominate artery, branch of aorta; H, right and left carotid branches (to head and neck); I, I, subclavian branches (to upper limbs); K, superior vena cava; L, pulmonary veins; C.*r.*, right coronary vessels; C.*l.*, left coronary vessels.

The heart possesses four chambers, two above, somewhat small,

and of thin walls, named the *auricles*, one lying to the right, the other to the left. They are essentially receiving chambers. Below them lie two larger chambers with greater capacity and thicker walls; these are termed *ventricles*, and are pumping or distributing chambers (fig. 2). They too are right and left. On each side of the heart the auricle communicates with the ventricle by means of its valved aperture, but there is no means by which the blood can pass directly from the right side of the heart to the left (fig. 3).

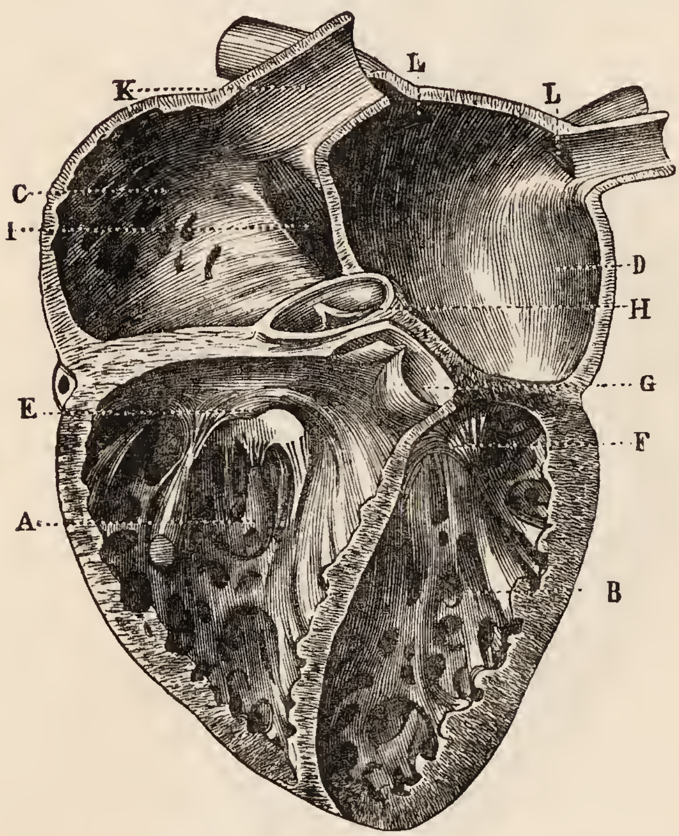


Fig. 3.—The Heart opened to show its Chambers

A and B, Right and left ventricles; C and D, right and left auricles; E, tricuspid, and F, mitral valves; G, pulmonary artery; H, aorta; I, orifice of inferior vena cava; K, superior vena cava; L, L, orifices of pulmonary veins.

Let us now follow the circulation of the blood through the various chambers, and let us begin at the right auricle—the right upper or receiving chamber. Impure blood pours into this chamber from every part of the body, being finally collected, for the purposes of discharge, into two large veins—the upper and lower hollow veins (or, as they are termed in medicine, the superior vena cava and the inferior vena cava). When the right auricle is full of this blood, which is dark in colour, it contracts and forces the blood onward through a valved opening into the right ventricle. When this in its turn is full it also contracts, and drives its contents (impure blood) through a second valved opening into a large artery called the *pulmonary artery*. This is the only *artery* that carries impure blood. No blood flows back into the auricle, because the valve

at the aperture between the chambers only opens towards the ventricle. If any blood, therefore, tries to flow back to the auricle, the valve closes and prevents its escape. In this way the blood is all driven on into the first part of the pulmonary artery, a very large vessel. As soon as the ventricle has emptied itself the pulmonary artery contracts, and the valve at its orifice closes to prevent the flowing back of blood into the ventricle. The blood is thus driven forward, and after a very short course the artery divides into two great branches, one for each lung. These entering the latter subdivide over and over again, carrying the impure blood to be purified, in the manner to be described in our next section. From each lung the pure blood returns to the heart by means of two *pulmonary veins*, that is to say, there are four pulmonary veins altogether, and these are the only veins in the body that carry *pure blood.* These veins all open into the left auricle (fig. 2), which thus receives pure blood, and when it contracts drives its contents into the left ventricle through an aperture guarded, as on the right side, by a valve. Finally the left ventricle empties itself, causing the blood to flow into a very large and thick-walled artery called the *aorta*, the largest artery in the body, and that from which all others directly or indirectly take origin. The blood is prevented from returning into the left auricle by the closure of the valve between it and the ventricle, and in like manner when the aorta contracts, a valve at its mouth closes and prevents blood finding its way back into the ventricle. This left ventricle has very strong muscular walls, because it has to drive the blood forward to supply distant parts of the body. Its own contractile force would never accomplish this, but it is aided by the arteries themselves, which have also strong and elastic walls which aid in the task of driving on the blood. It is this wave of blood passing along the arteries which we recognize at certain points, where the artery lies near the skin, as the *pulse.* As the heart contracts regularly 70 to 75 times a minute in an adult, we have a succession of waves constantly passing along, and these constitute the beat of the pulse, and their number per minute determine its rate.

But how does blood return to the heart? It is sucked or aspirated back by the relaxing auricles after their contraction, and it flows through the veins towards the heart, the venous trunks growing larger and larger as they acquire fresh tributaries, till at length they all unite into the superior and inferior venæ cavæ, pouring the total impure blood into the right auricle. The veins do not contract and drive the blood through them as the arteries do; their walls are thin and comparatively weak, and the blood is sucked along them by the expanding heart.

From this it comes about that the blood has a tendency to flow backwards in the veins, and to prevent this, the latter are provided with valves at suitable intervals. These valves only permit of blood passing onwards towards the heart; if any tends to flow back, the valves swing across the veins and stop the return flow. One may easily demonstrate the existence of the valves in a vein by selecting any large vein of the forearm, and with the finger trying to press the blood back in it towards the wrist. It will then be noticed that here and there in the course of the vein are little swellings. These are the valves blocking the channel of the vein. If from long standing, or the carrying of heavy weights, these valves become so stretched that they fail to act properly, the blood does find its way back past them, and the whole vein grows swollen and prominent, and is then termed *varicose.* Young children do not often suffer from varicose veins.

It will now be clear that there is no means of the blood passing from the right to the left side of the heart save through the lungs. On the right side there is always impure blood, on the left side always pure blood, and it is by the passage through the lungs that the change is effected. We represent this diagrammatically on p. 17.

Capillaries.—The smallest arteries (termed arterioles) end at length in a net-work of branching and uniting hair-like vessels named capillaries, whose walls are so thin that the watery parts of the blood, with nutritive particles in solution, can pass through them and so carry nourishment to the tissues.

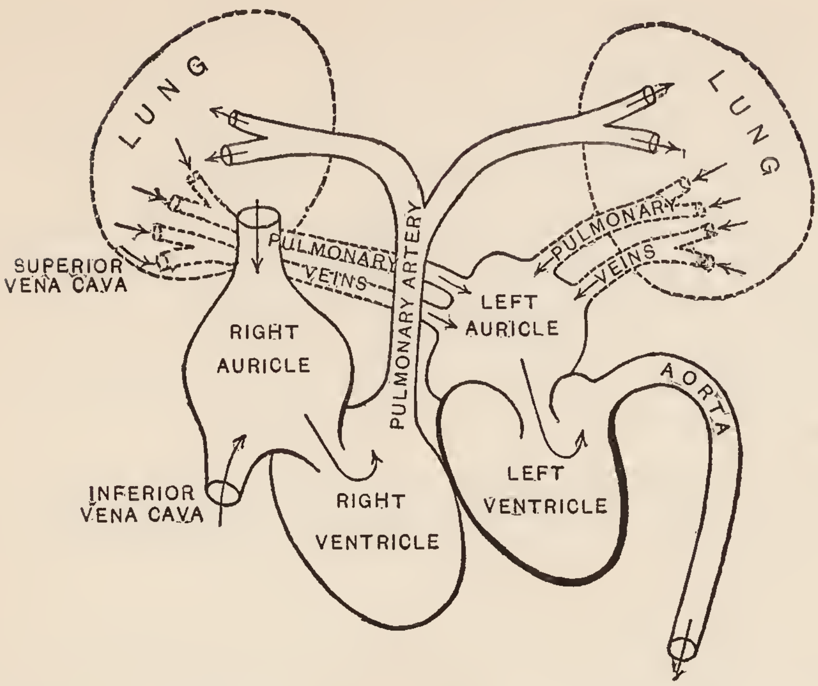


Fig. 4.—Diagram illustrative of the Circulation of the Blood. From *Ambulance Handbook*

Every part of the body has its countless capillaries, which, having given up nutritive material and received waste products and gases, unite to form the commencement of the veins.

The Blood.—This is a fluid of the greatest importance, and with it is indissolubly bound up the idea of life. Blood is composed of a watery part, the *plasma*, holding salts, gases, nutritive particles, and so forth, in solution, whilst suspended in it are countless little disc-like bodies, the blood-cells or *corpuscles.* The latter are red and white, the former being seven hundred times as numerous as the latter. The white cells play largely the part of scavengers in the body, their great function being to destroy harmful particles, especially microbes, which may have gained access to the body. The red cells contain a red colouring matter of much importance named *hæmoglobin,* which has the power of attaching oxygen to itself and of carrying this important gas to distant parts of the body, where it gives it up as required. As oxygen is needed for all vital processes, particularly in the growing child, it is all-important that the supply of hæmoglobin should be kept up to the normal. When a child grows pale and bloodless in appear-

ance it is because his hæmoglobin is falling in quantity and quality, and the oxygen-carrier being deficient, it is clear that the supply of oxygen must fall too, and so the whole body suffers. One of the elements out of which hæmoglobin is built up is iron, and it is well known that in cases of anæmia the use of iron in some suitable form as a medicine has a most beneficial effect. It forms one of the chief constituents of the well-known "Parrish's Syrup" so often given to children.

Certain Differences between the Circulatory System in the Adult and the Child

There are certain points of importance in this matter which should be touched upon. The heart of the child is relatively to the rest of the body of larger size than in the adult. The rate of its beat is much greater. At birth the pulse may be, and commonly is, 140 per minute. The adult pulse-rate is usually from 70 to 75. As the child grows older the rapidity of the heart's action decreases, but in general the rate is always faster in childhood. The following table indicates this:—

Age.	Pulse-rate per Minute.
Six to twelve months	105–115
Two to six years	90–105
Seven to ten years	80–90
Eleven to fourteen years	75–80

(Counted during sleep and absolute quiet; after Holt.)

In the next place, the pulse *varies* much more readily in rate in childhood than in adult life, generally in the way of getting faster. The least excitement and physical exertion will quickly send the rate up, among young children. Even in sleep, in infants, there is a difference of ten to twelve beats per minute, and so easily is the rate affected by emotion, that the only true way of getting a proper estimate of the pulse in very young children is to count it during sleep. Further, the arteries are supplied with nerves whose function it is to regulate the flow of blood through these vessels. Some of these

nerves constrict or narrow the vessel, others dilate them. The action of these latter nerves is very readily disturbed in childhood, which accounts for the sudden flushing of the face so often noticed in the young, under the influence of emotion, shame, fear, pleasure, and so forth. The pulse also in young children may become irregular, although no serious alteration in health exist. This is due to the ease with which the delicate nervous mechanism which regulates the heart's action is put out of order in children. Lastly, the blood-vessels in childhood are frequently much more delicate, and tend more readily (especially the very small ones) to break or rupture. For this reason, children in schools are often affected with nose-bleedings, as the delicate venules and capillaries of the lining of the nose easily give way. A bruise is simply an effusion of blood under the skin due to the same cause, viz., rupture of small vessels, and is often caused by a blow or a knock. Even a firm grasp of the arm of a child may leave bruise-marks under the skin, owing to the vessels giving way, and teachers should keep this in mind in handling young children, as a grasp of very moderate power, to pull an unruly or disobedient child into place, may leave marks suggesting that violence was employed. The same thing applies to boxing the ears, a practice that should be given up absolutely. Among other risks is this, that bleedings or hæmorrhages may occur under the skin, making the whole ear swollen, discoloured, and unsightly.

The Function of Respiration

In the air there exists a gas of great importance named oxygen, which must be taken regularly into the body, as it is absolutely necessary for all vital processes. Growth, muscular activity, the secretion of digestive fluids, and the mental processes, all require that oxygen should be supplied, and the function by which this is accomplished is *respiration*, which consists of a double act—the breathing-in of air, or *inspiration*, and the breathing of it out, or *expiration*. The composition of ordinary air is as follows:—

	Per Cent.
Oxygen	20·90
Nitrogen	78·10
Argon, helium, &c.	0·94
Carbonic acid	0·04
Hydrogen	0·019
Water vapour	traces

The oxygen and nitrogen thus exist in (roughly speaking) the proportion of 1 : 4, the latter gas acting simply as a diluent. The carbonic acid is important, chiefly as an indication of impurity. It is generally stated to be 0·04 per cent, or 0·4 per 1000 in fresh air, though more recent observations tend to place the amount at 0·03 per cent. In the air of cities, traces of hydrochloric acid, ammonia, and sulphur- and nitrous-gases are also present.

In the process of respiration, oxygen is taken in and used largely for the purpose of burning off the waste of the body, and of combining with various substances so as to produce heat and energy, the resulting product being chiefly carbonic acid gas, which is got rid of by the same channel as that by which oxygen is admitted, viz., by the lungs.

The Respiratory Apparatus

Air is first taken in through the nose and the mouth. It is of importance that the function of nose-breathing be cultivated, and this is best accomplished by learning it in early life. Air that is breathed through the nose is warmed by its close contact with the mucous membrane of that organ, and thus enters the windpipe nearer the temperature of the body than air that is inspired through the mouth. Not only so, but in respiration through the nostrils a great deal of foreign matter, dust, microbes, &c., are arrested, partly by the moist surface of the somewhat narrow channel, partly by the fine hairs that lie near its orifice. The lungs are thus protected to some extent against the entrance of material that might do them harm, and it is a well-known fact that those who breathe constantly through the mouth are very much

more liable to sore throats than those who breathe by the nose. It is therefore essential that teachers should keep this in mind, and try to inculcate a proper habit with regard to it, in those under their care. In some instances the mouth-breathing of children is merely a bad habit which can be corrected; in others it is an evidence of obstruction at the back of the nose, and requires special treatment. To this matter, reference will be made later on.

The air taken in by nose or mouth passes next through a narrow opening behind the root of the tongue into the voice-box or *larynx*, a short somewhat conical tube, chiefly composed of gristle or cartilage. Part of its front wall is well known to everyone as the "Adam's apple", a projection on the throat about two inches below the chin (fig. 5). Within the larynx are stretched the vocal cords, vibrations of which give rise to the fundamental tones of the human voice. The larynx is continued on into the windpipe or *trachea*, a tube some four or four and a half inches in length, and nearly one inch in diameter in the adult. It lies in the middle line of the throat, in front, and can be felt under the skin. If we trace its course down we find that it passes behind the upper part of the breast-bone, and divides there into two wide tubes or *bronchi* (single, *bronchus*), one of which goes to each lung (fig. 6). These bronchi subdivide again and again into smaller and smaller tubes (named *bronchioles*), and ramify all through the lungs.

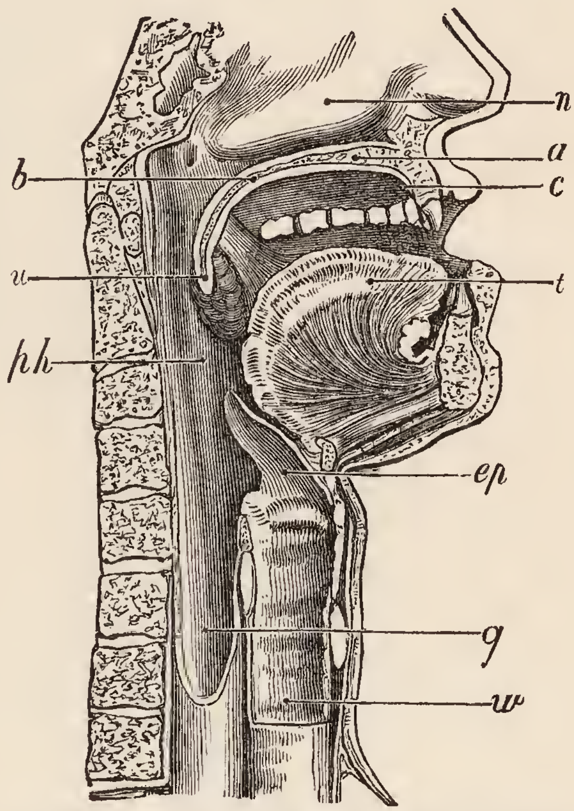


Fig. 5.—Section showing Mouth and Nasal Cavities, Gullet, Windpipe, &c.

t, Tongue; *ph*, pharynx; *ep*, epiglottis; *g*, gullet; *w*, windpipe; *n*, one of the turbinated bones of the nose; *a*, hard palate; *b*, soft palate; *c*, roof of mouth; *u*, uvula.

When each tube has subdivided sufficiently the terminal division ends in a little funnel-shaped *cul-de-sac*, termed an *infundibulum*, which bulges all over with little pouches, and these are the ultimate parts of the lung, or the air-cells (fig. 7). It is to these sacculated pouches that the inspired air, carrying with it the precious oxygen, eventually penetrates. How can the

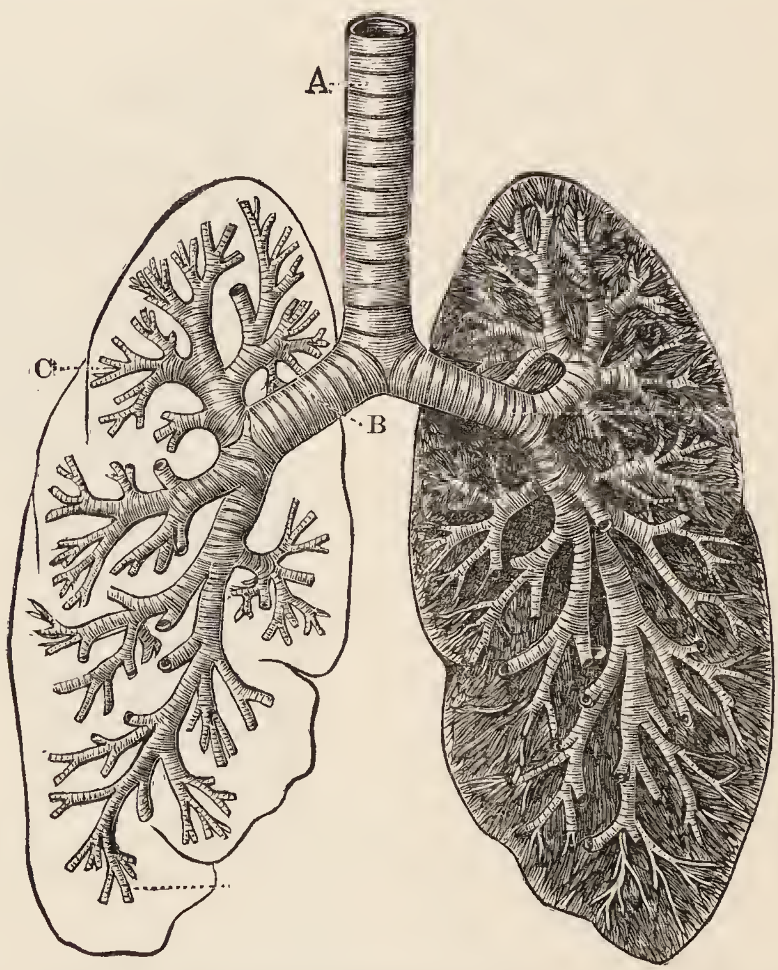


Fig. 6.—Section showing the ramifications of the Bronchi in the Lungs

A, Windpipe or trachea; B, bronchi; C, bronchial tubes.

blood make use of it, and how discharge its harmful carbonic acid gas?

Along with each bronchiole there runs a branch of the pulmonary artery with its load of impure blood; when at length the air-tube can subdivide no more, but spreads out in the infundibular swellings, the arterial twig spreads out as a net-work of capillaries over the air-vesicles. Now we have impure blood laden with carbonic acid gas (the product of

combustion in the tissues) separated from pure air with its 20 per cent of oxygen by only two very thin organic membranes, one the wall of the capillary in which the blood flows, one the wall of the air-vesicle containing the pure air. These membranes too are moist, and gases pass readily through moist membranes. Accordingly the carbonic acid gas from the blood diffuses out readily towards the interior of the air-cells, while the oxygen diffuses with equal ease inwards, enter-

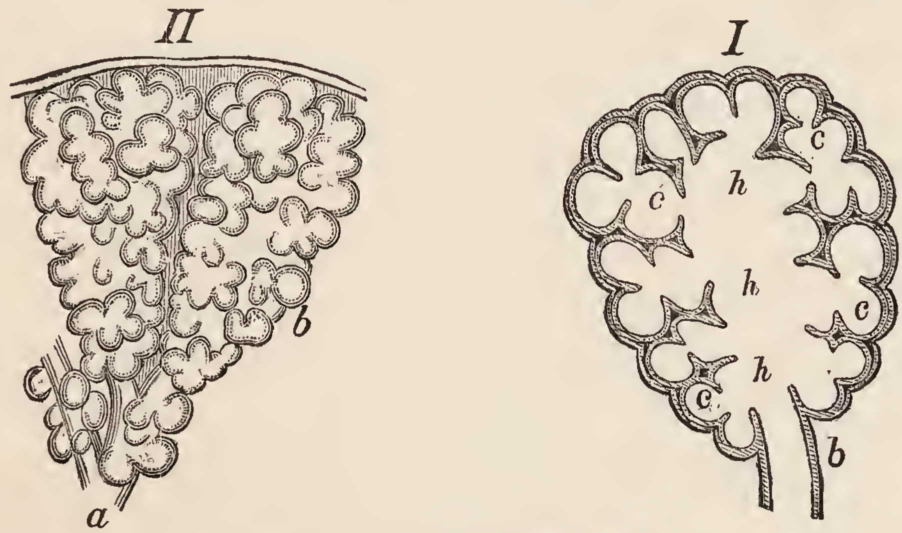


Fig. 7.—Air-cells of the Lung

II. A couple of air-sacs connected with one of the smallest bronchial tubes (*a*). I. Air-sac in section ; *h*, *h*, *h*, central cavity ; *c*, *c*, *c*, *c*, cavities of air-cells ; *b*, one of smallest bronchial tubes.

ing the blood stream. Here it attaches itself to the red colouring matter of the blood-cells, and changes the blood itself from the dark venous tint to the bright arterial hue. The capillaries holding this arterialized blood gather together and form the very first twigs of the pulmonary veins, the branches of which also travel by the sides of the air-tubes and convey the pure blood from the lungs, to pour it all, as we have learned already, into the left auricle of the heart. In this, then, lies the whole essence of respiration. It is the means by which gaseous interchange is effected, impure blood losing carbonic acid gas and gaining oxygen freshly inspired, while the carbonic acid gas escapes to the exterior by the act of expiration.

The Mechanism of Respiration.—The two lungs, with the heart, occupy the cavity of the chest, or *thorax*, which is

bounded in front by the breast-bone, at the sides by the ribs, and behind by the backbone. (See fig. 1.) The spaces between these various bones are filled up by many muscles. The thorax is separated from the lower part of the trunk, or *abdomen*, by a muscular partition, the midriff or *diaphragm*, which is dome-shaped, convex towards the chest and concave towards the abdomen. When one makes an inspiratory effort, the muscles attached to the ribs cause them to rotate upwards and outwards, the breast-bone moves slightly forwards, and so the width and the depth of the chest (from front to back) are increased. At the same moment the diaphragm becomes flatter, and so the floor of the thorax sinks. In this way the capacity of the chest is increased in every diameter, and as the lungs must follow up the movements of the expanding chest-walls the air-pressure within them diminishes, and the atmospheric air flows in through nose and mouth to fill up the pulmonary tubes and air-cells. This is the act of inspiration. Immediately thereafter the chest sinks again, partly through elastic recoil of its walls, partly through muscular action pulling down the ribs, the diaphragm rises, and, the chest capacity being lessened, air is forced out. This is the act of expiration. This is what occurs in ordinary tranquil breathing, but by employing what are known as the extraordinary muscles of respiration more air can be taken in, and more air can, of course, be breathed out. Men in ordinary breathing use chiefly the lower part of the chest (inferior costal type of respiration), while women employ the upper ribs and their muscles more (superior costal type); in children up to the seventh year the breathing is largely abdominal or diaphragmatic, and then as age advances it becomes more and more of the costal type.

In children the bronchial tubes are more numerous, and their calibre is greater than in the adults. The chest-walls are much more elastic, a point of real importance in reference to chest-expansion and breathing-exercises, of which we shall treat more fully later on. The rhythm of the breathing is often disturbed and irregular in childhood, and the rate is

higher than in adult life. A man, in tranquil breathing, respires 15 to 18 times a minute, perhaps usually 17 times. The following table indicates the differences in early life, the counting being done during sleep:—

Age.	Rate.
Infant	35 per minute
1 year	27 „
2 years	25 „
6 years	22 „
12 years	20 „

(Uffelmann.)

An adult takes in at every breath 20 to 30 cubic inches of air (in metric measurement, 320 to 480 cubic centimetres, written c.cm.); it is quite obvious that this relatively small volume of air cannot fill the lungs, and as a matter of fact it does not. It fills, however, the larynx, trachea, and perhaps part of the large bronchi, and from these, by the process of diffusion, the fresh air slowly mixes down to the farthermost air-cells, while impure air from these cells diffuses out. A child of seven takes in at each breath about $3\frac{1}{2}$ cubic inches of air (56 c.cm.).

It is clear that a large amount of air must pass in and out of the lungs every day. If an adult breathes 17 times a minute, and takes in at each breath 20 cubic inches of air, he will respire $20 \times 17 \times 60 \times 24 = 487{,}600$ cubic inches, or 282 cubic feet of air a day. If he take in, say, 30 cubic inches, he will deal with 730,000 cubic inches, or 422 cubic feet daily. This air (20 to 30 cubic inches) which is habitually changed at each breath is termed *tidal air*, as it flows in and out like the tide. In addition to this term, certain others are used in relation to respiration:—

1. *Complemental Air.* This is the amount that can be taken in, over and above the ordinary tidal air, by the deepest possible inspiration.

2. *Reserve or Supplemental Air.* This is what can be expired by the utmost force after an ordinary expiration.

3. *Residual Air.* This means the amount still existing in the lungs after the most violent expiratory effort.

In each of these the amount for an adult is about 100 cubic inches.

Respiratory or Vital Capacity.—This term expresses the quantity of air that can be expelled from the chest by the greatest expiratory effort after the deepest possible inspiration. It consists of the complemental + tidal + supplemental air, and in an adult is usually about 250 cubic inches (3500 to 4000 c.cm.). From observations made by the writer, on children in public elementary schools in Glasgow, the following average figures have been obtained:—

Age.	Sex.	Vital Capacity.
7 years	Boy	78 cubic inches (1130 c.cm.)
	Girl	50 " (800 ")
8 years	Boy	81 " (1300 ")
	Girl	50 " (800 ")
9 years	Boy	87 " (1390 ")
	Girl	57 " (900 ")
10 years	Boy	95 " (1515 ")
	Girl	75 " (1100 ")

The effect of physical exercises is well seen in the increase of chest measurements and of respiratory capacity which they produce, and this is to be regarded as one of their greatest advantages.

There normally exists a certain ratio between the respiration rate and that of the pulse. This ratio for ordinary persons is about 1 : 4; that is, if a man breathe 18 per minute his pulse-rate will be about 72. If his respirations rise to 20, his pulse increases to 80, and so on. Much the same ratio is found to exist among children, a boy of six years, for example, having a respiration rate of 22 and a heart-beat of 90 per minute, but, as already mentioned, the pulse is very easily quickened in children, and this ratio may readily be disturbed.

CHAPTER II

Respiration (concluded)—Changes produced in the Air by Respiration—Effect of Artificial Lights in Vitiating Air—Ventilation: its Principles and Practice—Natural Ventilation—Mechanical Systems.

Changes produced in the Air by Respiration

If we entered a well-aired class-room in a public school before the day's labours began, we should find it a pleasant enough place to work in, with its atmosphere of pure air. This would consist, as we have learned, of about 21 per cent of oxygen, of about 0·04 per cent of carbonic acid gas, and the rest would be mainly the inert gas, nitrogen. But after the lapse of some hours of occupancy the air would become much altered. If, in the first place, an analysis were made of the air in the inspired breath, and of that in the expired, it would be found—

1. That the oxygen had fallen from 20·90 to 16·03 per cent—a loss of nearly 5 per cent.

2. That the carbonic acid had risen from 0·04 to 4·4 per cent—a gain of 4·5 per cent.

It will, of course, be clearly understood that the whole air in the room does not suffer this change; this refers merely to the alteration in each individual respiration; but the net result at the end is a gradual gain of carbonic acid gas over the whole room, while the oxygen content falls.

The temperature of the air of an occupied room rises, chiefly from the warming of the inspired air in the respiratory tubes and cells, where it is near the warm blood, and partly on account of the heat given off from the pupils' bodies. In addition to this, the atmosphere of the room grows moister, vapour of water being constantly added from the lungs, and to a less extent from the skin. Not only is moisture added, but many small particles of organic matter are breathed, or coughed out of the throat. These are chiefly minute particles of the lining membrane of the back of the throat, windpipe, and bronchial tubes, with traces of mucus, of pus (or matter),

and last, but not least, of micro-organisms or germs in many instances. This moist, warm organic matter readily undergoes decomposition, and it is its presence that gives rise to the disagreeable smell of an occupied badly-ventilated class-room, church, or hall.

To recapitulate: the impurities produced in air by respiration are *gaseous* and *particulate*, the former being mainly carbonic acid gas, the latter consisting of particles of skin, mucous membrane, pus-cells, water, and of many microbes; at the same time, moisture and heat are added, and oxygen is used up.

What are the Effects of Breathing Air Vitiated by previous Respirations?

1. Perhaps the most important effects arise from the deficiency of oxygen. Till quite recently more stress was laid on other features in impure air, but it is now recognized that even a small falling-off from the normal percentage of oxygen is attended by listlessness, fatigue, and depressed bodily and mental functions generally. Oxygen is necessary for all vital processes; to no one is it more essential than to the young, active, growing child, with the increasing processes of growth, repair, and change.

2. The increase in carbonic acid is taken usually as a measure of the degree of vitiation in the air of a room, since the exact quantity of this gas can be readily estimated. Its actual harmful effects have perhaps been a little exaggerated, but there is no doubt that it is hurtful when it increases beyond a given point, partly because it excludes oxygen, and partly because as it accumulates in the air, it renders the diffusion of the same gas from the blood more difficult. Carbonic acid thus tends to remain locked up, as it were, in the body, and there to produce a slight narcotic effect, making the individual drowsy.

3. The rise in temperature of the room has an enervating effect; the nervous system loses its fineness of response, and the individual shows little readiness for bodily or mental

exertion. The heat also leads to dilatation of the skin vessels, and so to a flushing of the surface with blood. When the person goes out to the colder fresh air again, there is a rapid contraction of these vessels, and the result may be congestion of some important deep-lying organ, such as the lung or the kidney.

4. The added moisture may accumulate till the air is saturated at that temperature, that is to say, the dew-point is reached. Any further addition of moisture or any lowering of temperature will now cause a deposition of moisture on all objects in the room, including the skin, clothing, and hair of the occupants. Whenever the latter go out to the cool fresh air, exposed perhaps to a breeze, a rapid evaporation takes place, and a chill may result. Another undesirable result of too moist an atmosphere is, that it hinders the normal loss of fluid from the skin in the shape of insensible perspiration. As it is the latter that helps to regulate the temperature of the body, interference with it makes one hot, uncomfortable, and restless.

5. The increase in organic matter makes the air disagreeable, even offensive, and is to many persons peculiarly trying.

6. The addition of microbes or germs is of great importance with reference to infectious disease. In every class-room, hall, or meeting, there are several persons coughing every few minutes, and among these there may be more than one case of consumption, of unrecognized diphtheria, of tonsillitis due to infection, or of slight suppuration in the nose. These add many micro-organisms to the air, and some are bound to find, on being breathed in, a suitable soil for their growth and development in some fresh host.

All these bad effects are intensified in childhood. The child feels a hot, stuffy atmosphere even more than does its teacher. Its nervous system, active and responsive, is easily irritated, and the child readily grows peevish. The young brain-cells need plenty good blood, carrying abundance of oxygen. Deprive them of this, and their receptivity sinks far below normal, attention flags, and all the teacher's efforts become futile. Children, again, have a delicate vaso-motor mechanism

(see pp. 18, 94), and thus are very liable to chill, and above all they are particularly prone to infectious diseases, especially those in which the infective material gains entrance by the mouth, nose, or throat, such as scarlet fever, measles, whooping-cough, and diphtheria.

We have seen that the carbonic acid in ordinary pure air is practically 0·4 per 1000, and the quantity of this gas present is usually taken as an index of the degree of vitiation of air. The whole problem of ventilation is, how to supply a sufficient amount of fresh air per hour to a given number of persons occupying a given space, so as to keep the air at a reasonable standard of purity. Such a standard would be found where the carbonic acid gas in the room does not exceed 0·6 per 1000, *i.e.* 0·2 above that normally present. As a matter of fact, it is very difficult to keep the air of a school-room as pure as this, and Dr. Kerr has suggested that 1 per 1000 of carbonic acid may be taken as the limit permissible in schools; that is, the aim in ventilating a class-room should be to have at no time more carbonic acid than 1 part per 1000, less if possible.

Taking a mixed community, each individual gives off from his lungs per hour 0·6 cubic feet of carbonic acid. Men at work give off more, children yield less, as the following table shows:—

Subject.	Carbonic Acid in Cubic Feet given off per Hour.
Adult male—very hard work	1·96
„ light work	0·95
„ at rest	0·72
Adult female—at rest	0·60
Child—at rest	0·40
Average of a mixed community	0·60

It is not merely human beings who add carbonic acid to the air of an occupied room. A great deal is given off during the use of artificial lights (gas, oil-lamps, and candles). One cubic foot of coal-gas yields a trifle over 0·5 cubic foot of carbonic acid gas, and as a large flat-flamed gas-jet will use as much as 6 cubic feet of gas an hour, it will give off 3·0 cubic feet of carbonic acid gas, thus vitiating the air to the same extent as five women or seven children. The Welsbach incandescent

gas-light uses some 3 cubic feet of gas per hour, and gives off nearly 2 cubic feet of carbonic acid gas, or as much as three women or five children would.

As a result of various scientific investigations it has been found that in a mixed community (men, women, and children, let us say, in a room), if the air is to be kept at a good standard of purity, as much as 3000 cubic feet of fresh air must be admitted per hour. More is needed for men at work, as will be gathered from the table below:—

Subject.	Fresh Air required per Hour in Cubic Feet.
Adult male—very hard work	9800
,, light work	4750
,, at rest	3600
Adult female—at rest	3000
Child—at rest	2000
Average—mixed community	3000

Now suppose we desired to give 3000 cubic feet of fresh air per hour to a woman sewing in a room 10 feet square and 10 feet high, *i.e.* of cubic capacity of 1000. It is clear that the air would need to be entirely changed three times in the hour if 3000 cubic feet of fresh air were to be at the person's disposal. That is, 1000 cubic feet would need to be introduced every twenty minutes, and if the size of the opening where the fresh air entered was 1 foot square, the linear velocity of the entering air would be $\frac{5}{6}$ foot per second. Suppose, now, that the room were occupied not by one woman but by four. Four times as much air would be required, and with the same aperture of entrance its rate would need to be $\frac{5}{6} \times 4 = 3\frac{1}{3}$ linear feet per second, and at this rate it would cause a draught. One sees, then, that with a room of a given size, or what comes to the same thing, a definite cubic space in a room at the disposal of each unit, the amount of fresh air is limited by the rate at which such air can be introduced short of causing a draught.

It may be laid down that a suitable rate for the introduction of cold fresh air is from 2–$2\frac{1}{2}$ linear feet per second. If the air be warmed first, the rate may be increased to 8 or even 10 feet per second. By multiplying the sectional area in

square feet of the entrance for air by the velocity, we obtain the cubic delivery per second, and can readily calculate that for an hour. If a large school-room of, say, 600 square feet floor area, and 14 feet in height, were seated for sixty scholars of an average age of nine years, each child would have a floor-space of 10 square feet and a cubic area of 140 square feet at its disposal. If each child were to have 1400 cubic feet of fresh air per hour, the air would need to be changed ten times in that period of time, and it is clear that it becomes very difficult to do so without causing draughts, raising dust, and so forth. One would like to see all children in elementary schools getting from 1500 to 2000 cubic feet of fresh air per hour. This can only be accomplished by increasing their floor area (and thus their cubic space), since one becomes tied as to the rate at which fresh air can enter. Let the child have an initial cubic space that is ample to begin with, and then the air will not need to be changed so often. In some of the newer schools a very fair allowance of space is being given. In Provanside School, Glasgow, for example, the Infants' room, seated for seventy-two children, is $26 \times 26 \times 14 = 9460$ cubic feet in size, which works out at 130 cubic feet per head.

We may now discuss the best methods of changing the air in a room, in other words, the practical aspect of ventilation. Of the general methods there are two: *Natural* and *Mechanical*, each of which must be considered in detail.

I. Natural Ventilation

Given some means of communication between an occupied room and the external air, there are four ways in which ventilation can be accomplished:—

1. By the diffusion of gases.
2. By differences in temperature.
3. By the aspirating action of the wind.
4. By perflation by means of the wind.

Each of these merits a short consideration.

1. **Diffusion of Gases.**—The external air as well as the air in a room is a mixture of gases, as we have seen, the composition differing, however, in the two cases. Gases mixed like this, tend to diffuse and intermingle through the action and movement of their own molecules, and, according to Graham's law, the rate for each gas is inversely proportional to the square root of its specific gravity $\left(=\frac{1}{\sqrt{D}}\right)$. The kind of movement is quite independent of temperature. So, given foul air of one composition next fresh air of a different combination, there will be diffusion and so a mixing of the two, and to some extent the impure air will be diluted. This process, however, is too slow to be of practical value in ordinary ventilation.

2. **Movements of Air due to Differences of Temperature.**—This is a means of ventilation of great importance and of wide application. When air is warmed it expands readily, and, becoming of less specific density, rises. It ascends to the upper part of the room in which it is, and if there be means of egress it escapes. The total pressure within the room being now lessened, the external cold and denser air streams in at any suitable opening to take the place of that which has escaped. We have already learned that air, through respiration, becomes not only vitiated but warmed; so in any occupied room, a class-room, for example, the warm impure air tends to rise, and if a window be open at the top it may escape to the outside, while fresh air may flow in at a door or a ventilator. In many rooms there is another powerful means of setting heated air in movement: I refer to the chimney with a lighted fire below. Up the long and narrow flue there constantly rises, with considerable velocity, a stream of warm air. This is replenished by the cooler air of the room in its immediate neighbourhood flowing in at the opening of the fireplace, while this in its turn has its place taken by fresh air entering the room at the windows, doors, ventilators, &c. (fig. 8).

In this way the air of the room is constantly being depleted

of some of its impure air, and the place of the latter occupied by fresh air from outside. This is a ventilation method of great value. It is estimated that 11,000–18,000 cubic feet of air pass up the chimney of a small fireplace per hour, while in the case of a large one, the discharge is from 18,000–28,000 cubic feet. So important is this method that the model by-

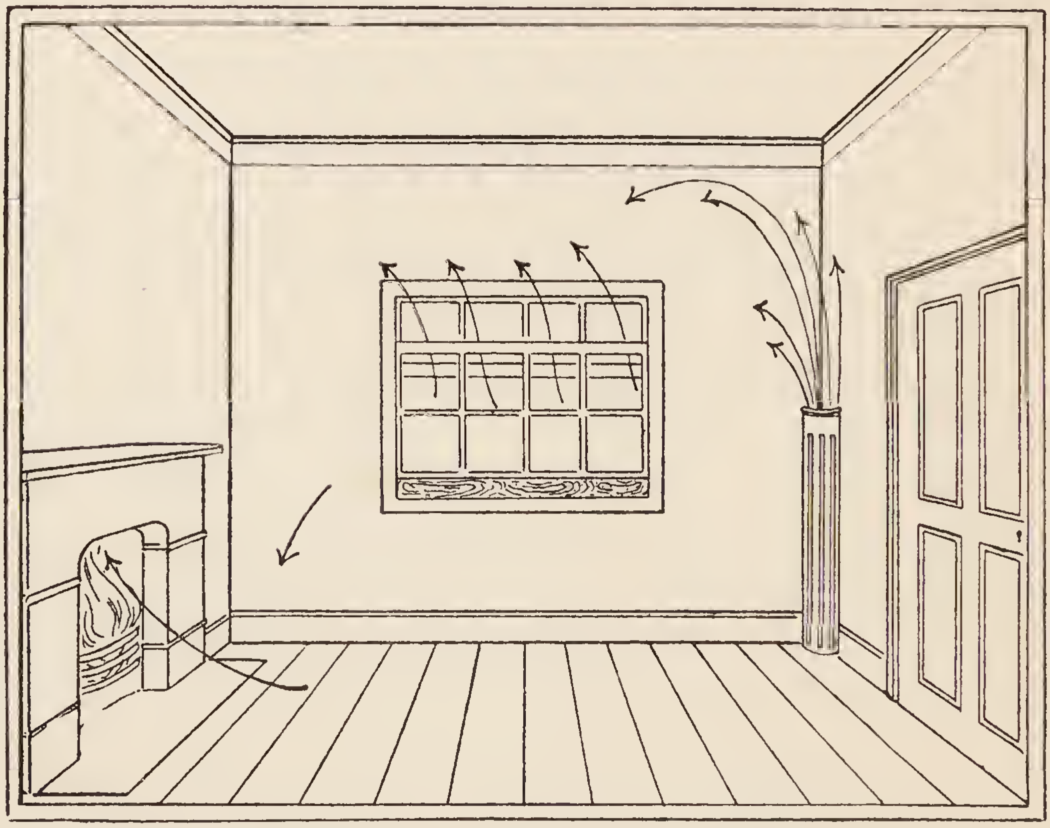


Fig. 8.—Air entering Room between Window Sashes and through Vertical Tubes. (After Teale.)

laws of the Local Government Board lay it down that no sleeping-room should be built without a chimney or flue communicating with the outer air.

3. **Aspirating Action of the Wind.**—When the wind blows over the opening of a chimney or other shaft connected with the interior of a room, it causes a suction out of part of the air in the chimney, thus causing a diminution of pressure, so that air from the room immediately streams up the shaft or flue to equalize matters. This takes place apart altogether from the presence of a fire. The air that has entered the shaft from the room is then in its turn aspirated out, and more flows into

the room from doors or windows to take its place. We see from this the advantage of having even a flue or air-shaft in a sleeping-room, although no fire may be used. This aspirating action of the wind is made use of in the roof-ridge ventilator to be described presently, and which is very suitable for single-storey school-rooms, small halls, and such like.

4. **The Perflating Action of the Wind.**—By perflation we mean a "blowing through". We understand by it that the impure air is driven bodily out of a room by the force of large masses of air entering at widely-opened doors and windows. The climate of the British Isles precludes the regular use of perflation. It is of constant use, however, in the tropics, and the ventilation of tents is largely by this means. It is the means employed in consumption sanatoria, where the object is to keep the patient constantly in the freshest possible air. There are certain occasions, however, where this method can be employed in schools with great advantage, and these are the intervals between classes, when the rooms are often emptied for a few minutes. This is the time to throw open windows and doors to their utmost extent, that large volumes of external air may flow in.

Ordinary dwelling-houses and many schools are ventilated by natural means, aided by some more or less simple mechanical device. The air may be changed in a room simply by trusting to the chimney for escape of warm air, and by allowing fresh air to come in, as best it can, below the door, or by means of the occasionally opened window. For those who sit or work constantly in one room, the window should always be open a little at the top, and the same thing applies to bedrooms. Many a child at school would have better health, and a more robust physique, if he slept in a better-ventilated room. Many devices have been introduced to aid natural ventilation, and a few of the best may be described.

1. **The Hinckes-Bird Plan.**—This consists in raising the lower sash of a window and inserting a board below it, perhaps 3 inches in width, and placed upon its edge on the

window-sill. It should extend for the whole breadth of the sash (fig. 9). It thus separates the sashes at the middle of the window, and allows fresh air to flow into the room at a height of perhaps 7 or 8 feet, without causing a draught, as it might if it entered at the level of the bottom of the lower sash.

2. **Tobin's Shaft.**—The nature of this will be readily understood from the figure. It consists of a shaft communicating with the outside air at its lower end, which should be protected by a perforated grating, to prevent the entrance of cats, birds, &c. After the shaft has passed through the wall it is carried up the inside to a height of 5 or 6 feet, and terminates in a mouth somewhat funnel-shaped (fig. 10). These tubes are usually made of wood, are rectangular in section, and sometimes have a valve inside to regulate the discharge of air. They not infrequently allow a good deal of dust to enter the room; this can be obviated to some extent by hanging a conical muslin bag in the internal aperture of the shaft with its apex downwards. This traps much dust, but hardly interferes with the flow of air. These shafts should be about 9 inches by 12, or 12 inches square, in section.

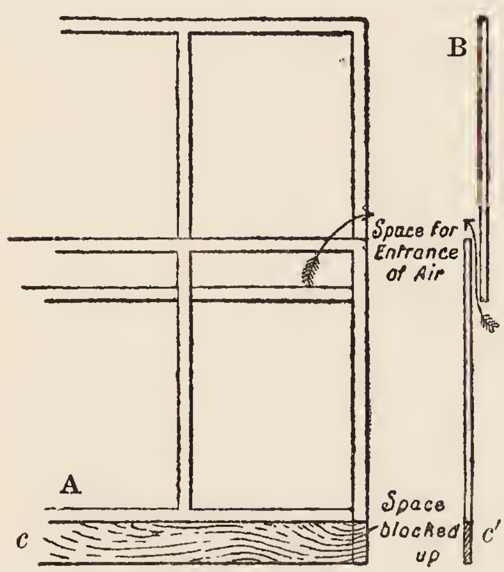


Fig. 9.—How to Ventilate a Room

A, Front view of window; B, side view; *c*, *c*′, ventilating board.

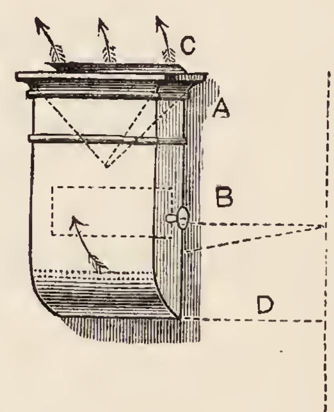
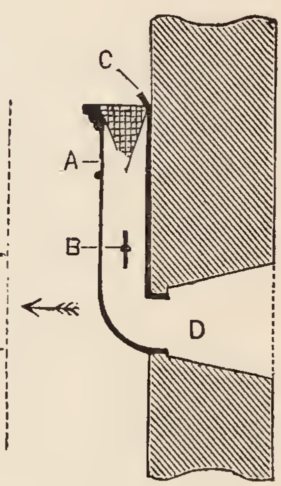


Fig. 10.—Wall Bracket Inlet on Tobin's System



Section of Wall Bracket Inlet

3. **Sheringham's valve** is well known, and needs little description (fig. 11). It provides a hopper-like opening when in

use, and gives the entering air an upward direction, so that it spreads out and diffuses gently through the room. These valves are usually placed fairly high up on the wall. The upper parts of church or school windows frequently open forward like this, thus allowing of the entrance of air without draught (fig. 12). Sheringham's valves may be employed with advantage in schoolrooms as aids to natural ventilation.

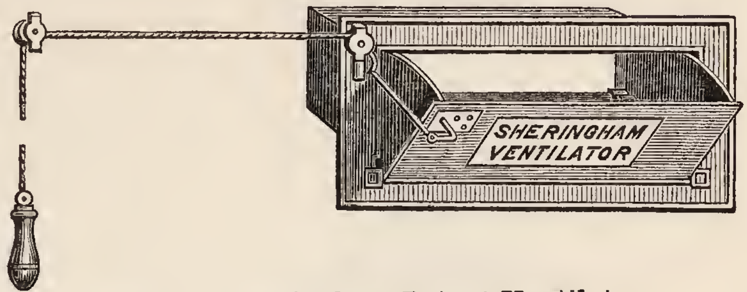


Fig. 11.—Sheringham Patent Ventilator

4. **Ellison's conical bricks** provide another means of introducing fresh air. The bricks have a conical opening in them,

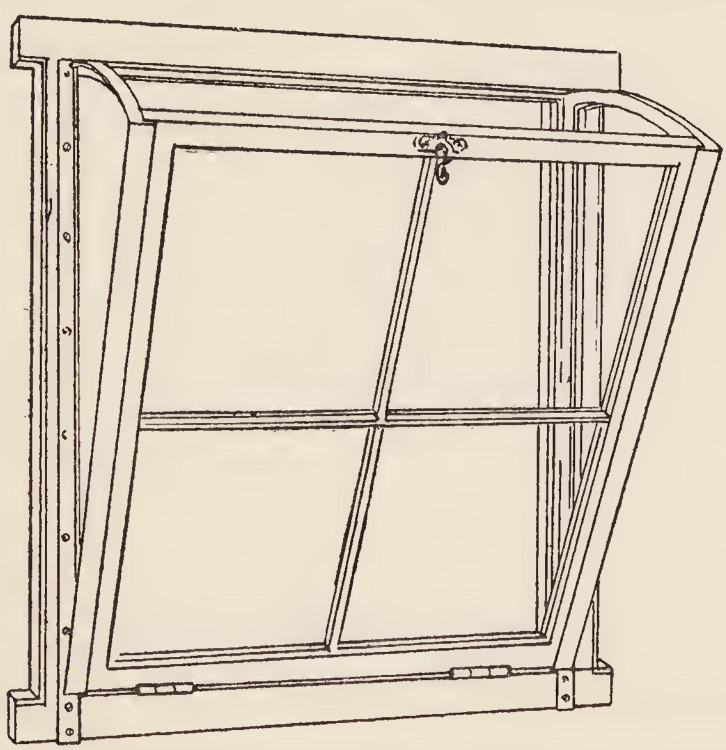


Fig. 12.—Upper Part of Window opening forwards for Ventilation

and they are so placed in the wall that the wide end of the perforation is towards the interior. The air entering from the outside thus gets dispersed before it passes into the room, and there is less risk of a direct current impinging on the bodies of the inmates.

5. **M'Kinnell's Ventilator** consists of two tubes (fig. 13), which are fixed in the roof of a room so as to communicate with the external air. It will be noticed that one tube is fixed inside the other; this inner tube is to allow the warm vitiated air to escape, while the wider surrounding tube (provided at its inner end with a flanged edge) is for the entrance of fresh air.

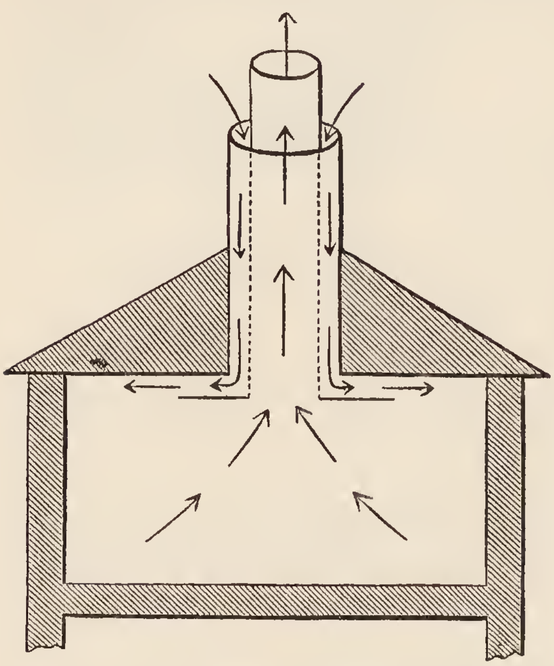


Fig. 13.—M'Kinnell's Ventilating Shaft

6. **Louvred Ventilators.**—These are occasionally employed, and consist simply of an aperture without glass, but guarded by wood louvres. The latter permit of the entrance of air, while they exclude rain (fig. 14). In some instances the louvres are so arranged that by pulling a cord they are made to lie more vertical, practically overlapping one another, and in this way the entrance of air may be largely cut off if desired. They are employed much in hothouses, meat-safes, and in cases for holding meteorological instruments (as in Stevenson's screen).

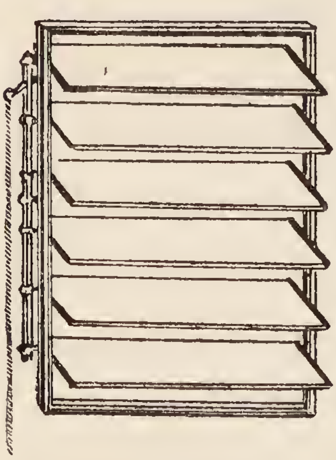


Fig. 14.—Louvred Ventilator

7. **Currall's Door-Ventilator.**—In natural ventilation a good deal of fresh air comes in under the door. This tends to chill the feet of the inmates, and to affect their health and comfort. A simple plan has been suggested to overcome this, and that is to admit the fresh air through a long slit or aperture, or through a series of holes made in the upper part of the door. In order that the air may not fall on the heads of the inmates, a little metal plate may be fixed on the inside to give the

entering air an upward direction. A similar plan may be adopted for windows.

The foregoing list does not exhaust the number of minor mechanical aids to ventilation, but it comprises the most important. We can see that by their aid a class-room can be efficiently ventilated without any large elaborate system. Given a room with a good fireplace and chimney, windows reaching to the ceiling, and opening easily from above, and some means to facilitate the entrance of fresh air, such as a couple of Tobin's shafts, a large Sheringham valve, or the like, the air can be kept in a state of satisfactory freshness. The impure air escapes continuously up the chimney, and near the ceiling above the pulled-down upper window-sash, while fresh air enters between the sashes at the middle of the window, under the door, and by means of the Sheringham valve or Tobin's shaft. At all intervals, the windows and doors should be widely opened so as to permit of the perflating action of the wind, and of a rapid change of the air of the interior.

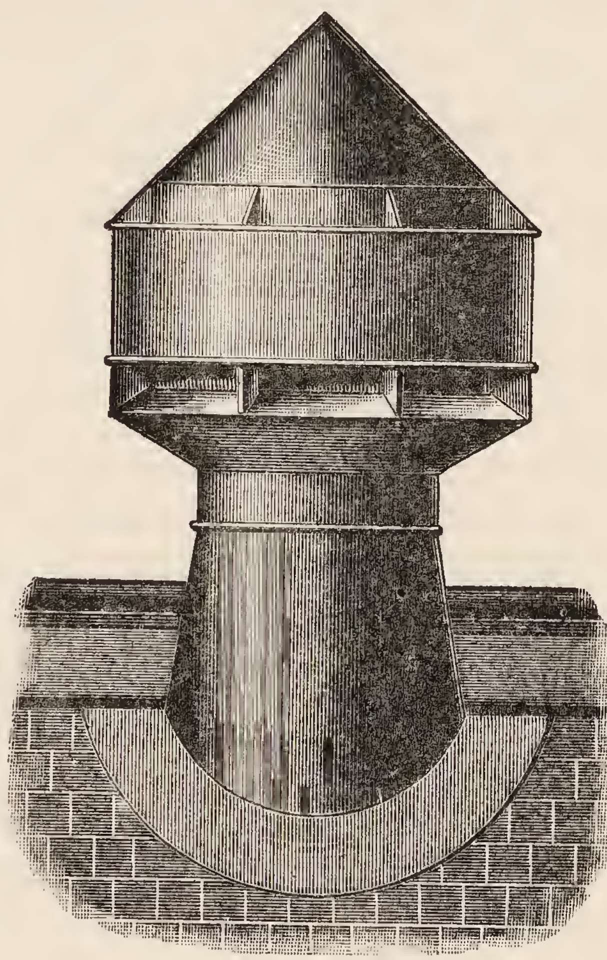


Fig. 15.—Roof-ridge Ventilator

Roof-ridge Ventilator.—This is a little more elaborate than the devices already mentioned, and depends on the aspirating action of the wind. It is well suited for the ventilation of a one-storey or top-storey class-room, and consists of a shaft, usually bent at an angle, communicating at its inner end with the room, and ending externally in a fixed or rotatory cowl

(fig. 15). The wind passing across the top produces a partial vacuum, and sucks the warm foul air from the upper part of the chamber. To prevent the wind blowing down, in the reverse direction, the shaft may have a light silk valve, in a valve-box, which only opens outwards. Air can thus escape readily, but if a "back-draught" arise, the valve will close.

In general, it may be said that where natural means are relied on, the apertures for entrance of fresh air should be multiple and placed somewhat low, while the outlets for foul air should be collected together as much as possible, and placed high up.

II. Mechanical Systems of Ventilation

These involve the use of more elaborate mechanism than the foregoing, but are largely employed in large public schools on account of their uniformity of action. They may be divided into two great classes: (1) *The Propulsion or Plenum System*, and (2) *The Extraction or Vacuum Plan.*

1. **The Propulsion System.**—This method is largely adopted in large schools, and consists in *driving* the fresh air from the exterior, by means of a large fan, into the basement of the building, and distributing it, by means of shafts, to all the class-rooms. To describe the method in detail let us consider an actual case. In a school with which the writer is acquainted there are in the basement two fans, each 6 feet 3 inches in diameter, driven by a 15 horse-power electric motor. Their first action is one of suction—they draw in the outer fresh air, which is taken in at the level of the playground, and sucked through a horsehair screen 20 feet long by 8 feet high, kept constantly wet by a stream of water trickling over it. By this means the air is washed, and largely freed of dirt and micro-organisms. It has been suggested that the air should be taken in from a higher level of the atmosphere, by means of a tall air-shaft whose lower end would be near the washing-screen, the idea being that such air would be cleaner than that near the ground. This, however, is not usually done, and as the

air in any case is cleansed, it does not really matter very much.

The air is now drawn, still by suction, over coils of hot-water pipes $2\frac{1}{2}$ inches in diameter, supplied from a special boiler in an adjacent room, and so is warmed to any desired temperature. The aim is generally to deliver the air into the class-rooms as near a temperature of 60° Fahr. as possible. The air thus screened and warmed now strikes on the revolving fans, and these drive it into a central passage, along which, at intervals, there are large openings some 5 feet high by 2 feet wide, placed at a height of a few inches from the ground. These communicate with vertical shafts leading to every class-room. At the latter the fresh warmed air enters by a hopper-shaped opening 4 feet long by $1\frac{1}{2}$ wide, and placed at a height of 9 feet from the floor. The windows (which should be made so that they *can* be opened if required) are kept entirely closed, there is no fireplace, and the air already in the room is *driven* out by that entering, propelled as it were, and escapes at a grating 3 feet long by $2\frac{1}{2}$ wide, placed in one corner near the floor. From this point a shaft leads it to the roof, where it finally escapes. In hot weather the pipes for heating are not employed, and if desired a spray of water can be turned on in the basement passage, so as to moisten the air further after it leaves the fans, and before it enters the distributing shafts (fig. 16). This is the general scheme of the Plenum method, employed in a number of schools in Great Britain.

2. **The Extraction or Vacuum Method.**—This is not used quite so extensively as the Propulsion plan, although it has many supporters. The idea underlying it, is to extract or draw out the foul air, when fresh must flow in of its own accord. Now whereas propulsion is only carried out by fans, extraction can be done by means either of fans placed at the roof of the apartment or building, or by means of an ascending current of warm air in what is called an "up-cast shaft". Each of these may be briefly described.

(1) When fans are used they are placed high in the room or building near an outlet, and by their motion they draw

towards them the warmer, lighter, vitiated air, and cause it to flow out at the exit. Its place is taken, of course, by fresh air entering at the door, windows, or other places. The fan may be driven by an electric motor or a gas-engine, and its size will vary with the volume of air it has to deal with.

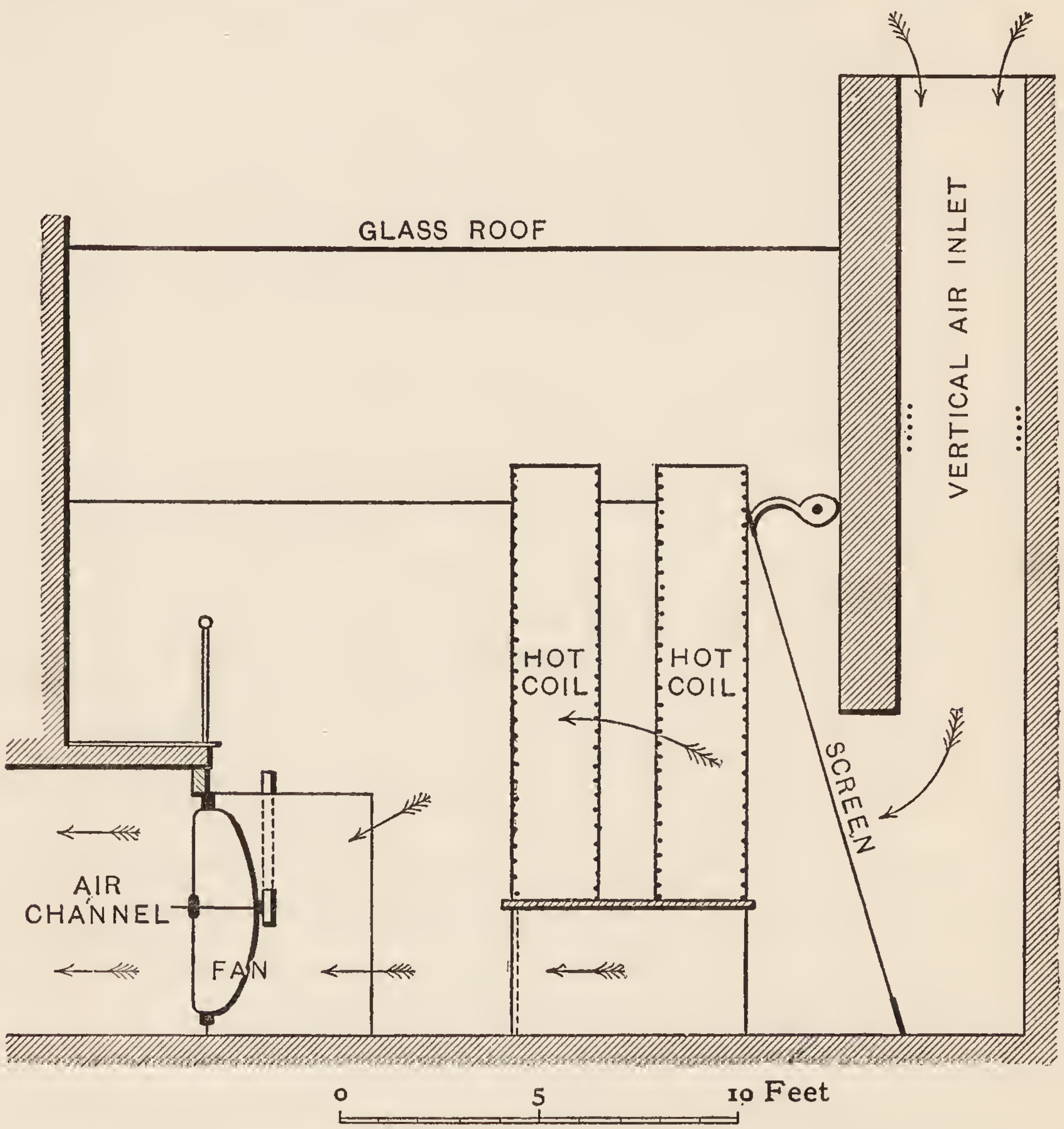


Fig. 16.—Working Parts of Plenum System of Ventilation, by which the Air is screened, washed, warmed, and propelled into the Building to be Ventilated. (After Glaister.)

Hillhead Public School, in Glasgow, is an example of an educational establishment ventilated in this way, which is also largely used for halls, churches, and restaurants.

(2) The foul air may be extracted by means of a constantly ascending current of warm air in a tall shaft or tower. This is the method employed in the ventilation of the House of

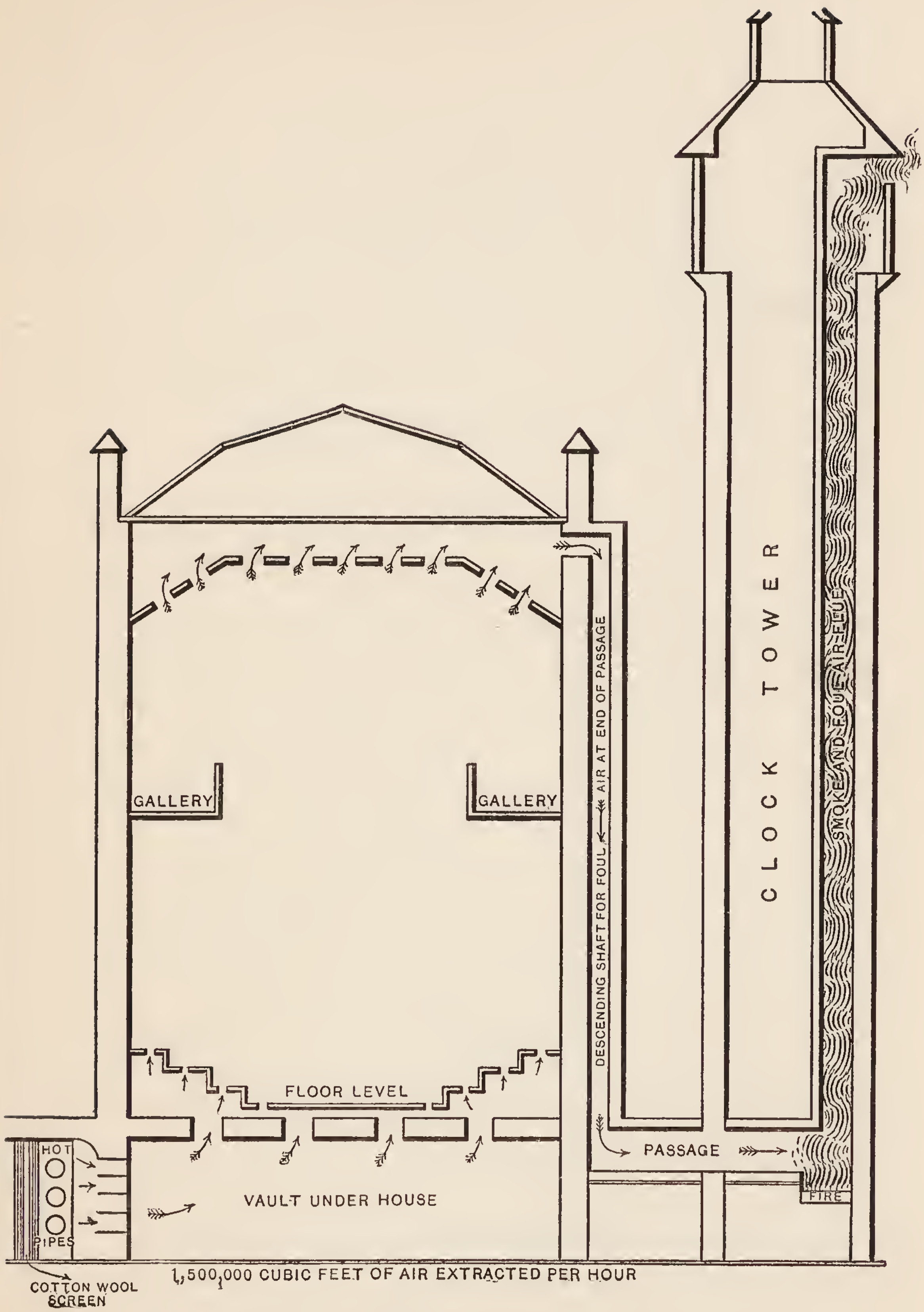


Fig. 17.—System of Ventilation and Warming adopted in the House of Commons

Commons (fig. 17), where 1,500,000 cubic feet of air are extracted per hour. The escape flue ascends by the side of the Clock Tower, and has a source of heat at the bottom which ensures a constant movement upwards of the air. It thus extracts the air from the upper part of the large chamber of the House (through the perforated ceiling), and this as it escapes is replaced by fresh air that enters by floor-gratings. This entering air is first washed and warmed in the basement of the House.

This plan is not much employed in schools. Used in conjunction with a propulsion-fan it serves for the ready removal of impure air, and an arrangement of this kind is to be found in Birchfield Road Board School, Liverpool. It is, in the writer's opinion, an unnecessary addition to a propulsion system.

There is still diversity of opinion as to whether the Plenum or the Vacuum method is the better, but the general trend is in favour of the former, on account of the greater ease with which the delivery of air can be regulated, and the choice which the engineer is able to make as to the source from which the air may be drawn. In the extraction method, as air is drawn out, more air comes in at any point it can to take its place, and there is a greater likelihood of draughts. In any case, gratings in the floor are to be avoided as points of entrance of air, since there is a great likelihood of the feet becoming chilled unless the air is always introduced well warmed.

I have dwelt with some fulness on this question of ventilation, as, in my opinion, it constitutes one of the most important factors in successful school-life. No good teaching can be done, and no satisfactory learning accomplished, in a bad atmosphere. The body, the mind, and even the moral nature suffer, for it engenders irritability, bad temper, crossness, and leads perhaps to injustice. An abundant supply of fresh air improves the whole bodily well-being of the scholar. Colds and sore throats, tuberculosis and acute infectious diseases are lessened in their incidence, while their evil effects are, in some cases, less severe when they do attack. Mental brightness and alertness take

the place of apathy and listlessness, and the moral tone of teachers and pupils alike is raised.

CHAPTER III

The Heating of Schools—Fireplaces—Stoves—Gas-fires—Oil-stoves—Hot Air—Hot-water Pipes—Electric Radiators—Lighting of Schools—Sun-light—Gas—Lamps—Electricity—The General Structure and Arrangement of Schools—Site—Aspect—Buildings—Corridors—Cloak-rooms—Class-rooms.

The Heating of Schools

The proper heating of school-rooms is a matter of importance, because proper work cannot be done if the feet and hands are cold and the body chilly. Various means are adopted to warm class-rooms, and the aim should be to maintain the room at a temperature as near 60° Fahr. as possible.

Heat is a form of energy, and is transmitted from one point to another in three different ways, viz., by *conduction*, *convection*, and *radiation*. The *conduction* of heat is seen when the heat spreads along by direct contiguity, as, for example, when the handle of a poker grows hot because its point is thrust into a glowing fire. The walls near a fireplace grow warm, and the heat can pass along these walls from particle to particle by the process of conduction. In *convection*, on the other hand, we have a mass of heated air (or, it may be, heated water) moving, and so conveying heat to a new place. The warmer and therefore lighter medium rises, and as it does so dispels from its position the cooler layers above, causing them to sink and to become warmer in their turn. In convection we thus have the conveyance of heat by gross movement of the heated layers. It is, however, by *radiation* that heat is generally distributed. In radiation the heat-energy is emitted from the hot body in a series of successive waves, which travel from it in all directions, their intensity growing feebler as the distance increases. It is by this means that heat reaches us from

the sun. It is by this process that we feel the warmth of a fire when we stand several yards back from it, and it is thus that heat reaches out from ordinary hot-water pipes. The radiant heat as it falls on bodies is absorbed, transmitted through, or reflected by them. A polished metallic surface radiates badly, a dull surface well. Therefore to keep hot water and tea warm we place them in polished vessels of copper or silver, while in warming a room by pipes we keep the latter (the radiators) dull and unpolished, or else painted a dark colour.

Various Methods of Heating

1. **Open Fireplaces.**—These are still used a good deal, and are very suitable for class-rooms of medium or small size. They act, too, as great aids to ventilation. The old-fashioned "quick-burning" grates are very wasteful, a large percentage of unburned fuel escaping up the chimney as carbon smoke. In the "slow-combustion" grates the air is only admitted in front through vertical bars, not below as in the old grates. The fireplace is built nearer to the hearth than in the old-fashioned variety, and the narrow space below, into which ashes fall, is closed with an iron plate, which

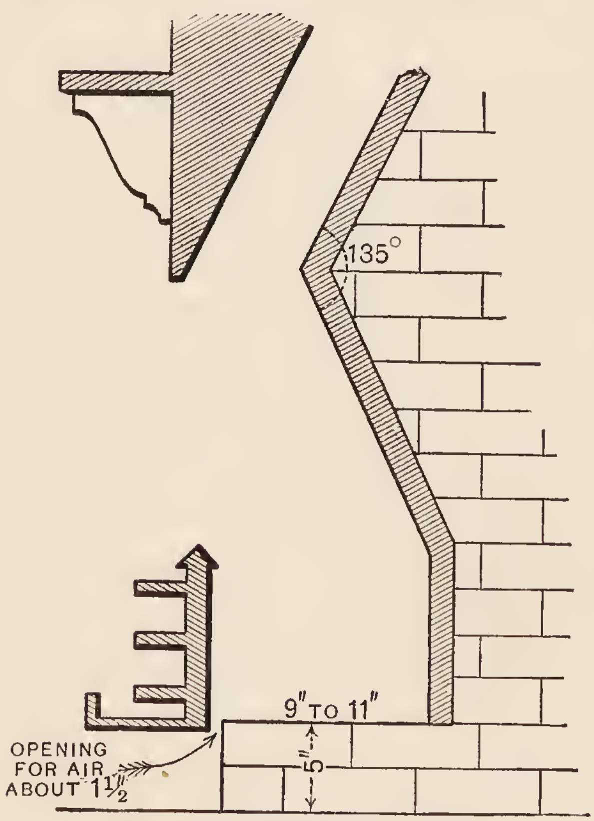


Fig. 18.—Hygienic Fireplace

can be lifted out to permit of the removal of ashes. The air only enters through the vertical bars in front, and so the rate of burning is moderated. The back and sides of the fireplace should be built of fire-brick, which gets heated up steadily, and then continues to radiate heat out for a long time. The

chimney "throat" should be narrow, and the sloping back of the fireplace should meet the chimney at an angle of 135° (fig. 18). Fireplaces, of course, always give rise to a certain amount of dust.

2. **Closed Stoves.**—The employment of stoves is much more common on the Continent, and in the United States and Canada, than in this country, but occasionally one may find a school-room warmed by this means. Stoves are usually made of cast-iron, or cast-iron covered with tiles, bricks, or porcelain, and have certain advantages in that they are economical, give out a maximum of heat for the fuel employed, require little tending, and radiate uniformly. But certain very distinct disadvantages attach to them too. They are but poor adjuncts to ventilation; they dry the air of the room too much; they may become overheated, so that organic dust in the air falling upon them becomes charred and gives the air a disagreeable odour; and, lastly, they may permit the passage through them of harmful gases from the burning fuel. When cast-iron becomes heated, it permits of the passage through it of various gases, and one of these gases, always produced to some extent in the process of slow combustion that goes on in stoves, is very poisonous. It is named *carbon monoxide*, and results from incomplete oxidation of charcoal or coal. The merest traces of this gas in the air of a class-room would be sufficient to cause malaise, headache, and even graver symptoms. It is therefore essential that stoves, wherever used, should be provided with a thoroughly efficient flue for the escape of gases produced in their interior. The Board of Education disapprove of the use of stoves for warming class-rooms, and only sanction their employment when they are made to conform to certain conditions, to which I shall revert later. Another objection to stoves is that they take up floor-space in the class-room.

3. **Gas-fires and Gas-stoves** are not often employed. The former are, in the writer's opinion, perfectly safe, and very suitable for heating a medium-sized room used occasionally, provided always that the gas-fire is laid in an ordinary fire-

place with a good flue. Gas-stoves standing out in a room are very objectionable, and give off harmful or unpleasant gases, and dry the air.

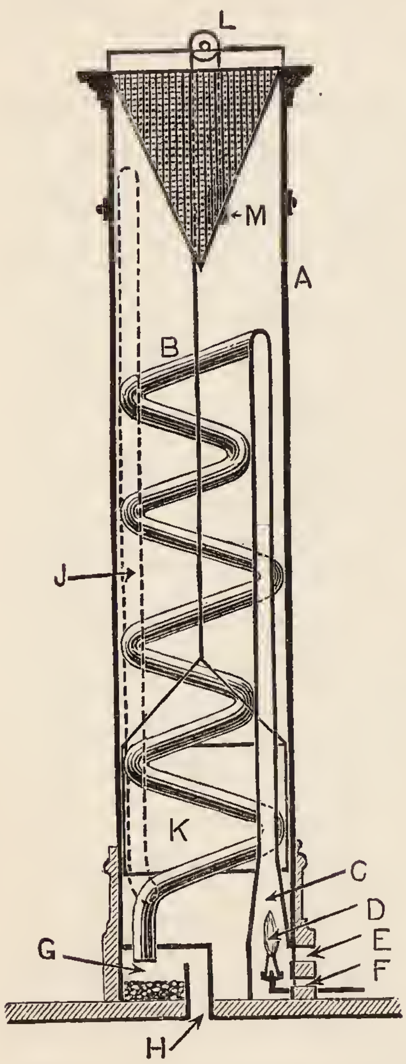


Fig. 19.—Air-inlet Tube fitted with Fresh-air Warming Arrangement (Boyle)

A, Air-tube; B, coiled pipe; C, chamber for gas-jet; D, gas-jet; E and F, fresh-air inlets for gas-jet; G, H, means of escape of heated gas; J, another means of same; K, shutter to regulate entrance of air to room; L, cord for raising or lowering shutter; M, counterpoising weight.

4. **Oil-stoves.**—These are practically never used in schools. They might find occasional use, for small rooms in country districts. They must be kept very clean, as spilt oil, when heated, gives off very unpleasant odours.

5. **Hot Air.**—This is not often employed *per se* in warming schools, or indeed for any class of building. But in the mechanical systems of ventilation, described in last chapter, the air is warmed before being discharged into the class-rooms, and in this way ventilation and heating are combined. The heat of the room is really provided by the entering warmed fresh air; no other source of heat is then required. In a thoroughly modern school with which the writer is acquainted, fresh air is admitted a foot or two above floor-level in the class-room, and passes at once over the coils of a hot-water radiator. It is directed upwards by a glass plate fixed at an angle, and enters the room without causing any draught. Foul air is allowed to escape by the upper parts of the window, which are hinged so as to fall forwards (see fig. 12). In this way, warm fresh air is admitted. In Boyle's air-inlet tube, air is warmed before admission by means of a gas-jet, and so helps to heat the room which it enters (fig. 19).

6. **Hot-water Pipes.**—These are very commonly employed

for schools, hospitals, churches, public libraries, and other large buildings. They may be employed in either the *low-pressure* or the *high-pressure* system (fig. 20). In the former the pipes are usually of cast-iron, 2 to 4 inches or more in diameter, and carry hot water at a temperature not above that

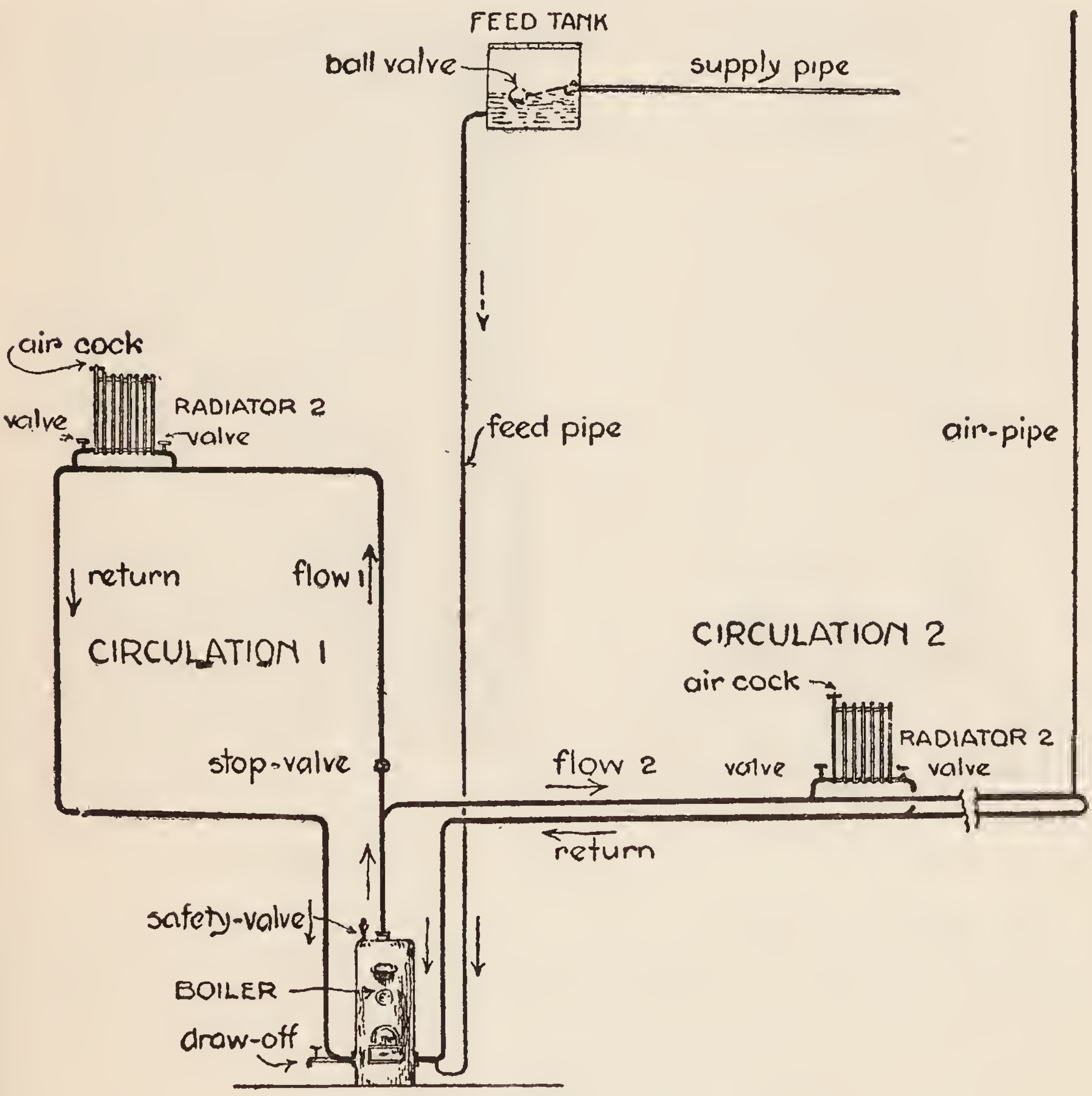


Fig. 20.—System of Hot-water Pipes

of the boiling-point (212° Fahr. or 100° C.). The source of heat is a boiler in the basement of the building. The only objection to this system is that in very cold weather the pipes at the top of the circuit (and therefore the coldest) may freeze.

In the high-pressure system the pipes are smaller, 1 to $1\frac{1}{2}$ in. in diameter, are made of wrought-iron, and hold water heated

up to perhaps 150° C. under pressure. The pipes are heated by passing through a fire. The risk attendant on the method is that the pipes may burst from explosion.

7. **Electric Radiators.**—Occasionally these are used for heating rooms, and it is likely their use will become more

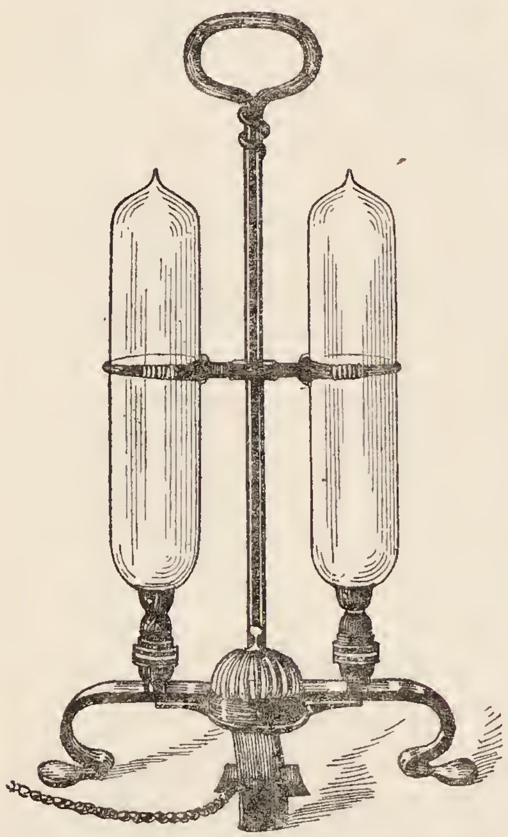


Fig. 21.—Verity's "Aston" Electric Radiator

Fig. 22.—Rashleigh Phipps & Co.'s Electric Radiator

general. They add heat to the air, but no gases, moisture, smoke, or dust. Examples of these are seen in figs. 21 and 22.

The Lighting of Schools

1. No light surpasses the natural light of the sun, and one should endeavour to do as much work as possible in schools by daylight. Windows should be large and well placed, and made as completely as possible of clear glass. Details as regards the size and position of windows will be found in the next chapter, when the structure and arrangement of school-buildings will be considered at greater length. Unfortunately, in great cities like London, Glasgow, Manchester, and Liver-

pool, where much manufacturing goes on, the daylight is often obscured by smoke, and at times is practically reduced to twilight through the occurrence of fogs, so that artificial lighting becomes a necessity. Where evening classes are held, of course artificial light must be employed.

2. **Coal-gas.**—This is still the most common artificial illuminant in general use. Unfortunately the use of coal-gas leads to the addition of much carbonic acid to the air, which also becomes much warmer. The presence of sulphur compounds in ordinary gas leads to the production of traces of sulphurous and sulphuric acids, and these have a prejudicial effect on the bindings of books. A considerable amount of water-vapour is also added to the air, and in course of time the ceilings become darkened through the deposit of unburned carbon escaping from the gas-flame. In spite of these defects, however, ordinary gas and ordinary burners are still largely used. As pointed out when dealing with vitiation of air, under Ventilation, the incandescent burner is less harmful than the ordinary one, in the way of adding impurity to air, and at the present time such burners are widely used in ordinary houses and shops. The fragility of the "mantles", however, makes them somewhat unsuitable for schools, where so much movement and vibration occur.

3. **Oil-lamps.**—These are much employed in country districts in the absence of gas. Oil in burning yields water-vapour and carbonic acid gas. One pound of oil requires as much fresh air for its combustion as do 10 cubic feet of coal-gas, and in an hour will vitiate the air as much as several men. A good oil of a high "flash-point" should be used, and the lamps should always have metal reservoirs, which will not break if the lamp be turned over by accident.

4. **Acetylene and Carburetted Water-gas.**—These are not employed in school-lighting in this country, as far as the writer knows, although acetylene might be used quite suitably in rural districts if there were anyone to take charge of the installation. The stations on a new railway line in Fife, completed in the summer of 1906, are lit by acetylene. Water-

gas should never be used for schools. It is cheap, but very poisonous, containing a large percentage of carbon monoxide.

5. **Electricity.**—This as a means of lighting is coming more and more into use in the large schools of cities, and is an admirable illuminant. As the incandescent filaments which emit the light are enclosed in vacuum bulbs, there is no vitiation of the air. Neither is carbonic acid added nor oxygen removed from the air, nor is water-vapour given off. The only change produced is the addition of heat. These are great advantages, for, bearing in mind the high importance of pure air for children in school, we should try to secure an artificial illuminant which will deteriorate the air as little as possible.

The Structure of Schools

We are concerned here chiefly with the large public elementary schools of cities,—the places where most of the primary education of the country is carried on, and it is only right that the well-trained teachers of to-day should possess a proper knowledge of what is hygienically correct in the place where they carry on their professional work. The rules regarding the planning and fitting of public elementary schools are laid down by the Board of Education (July, 1905) in England, and by the Scotch Education Department (February, 1906) in Scotland. The regulations in the two countries agree very closely. There are also building Regulations for secondary schools and pupil-teacher centres issued by the English Board, but no similar code exists in Scotland.

Site and Aspect.—The buildings should be on a clear, open site, somewhat elevated if possible. Proper playground accommodation is an essential. Exclusive of small annexa, there should be a clear space of one-quarter acre, as a minimum, for every 250 children in the school. If the school is more than one storey high the area may be proportionately increased, but not less than 30 square feet per child should be allowed in any case (Scotch Code). If the buildings are practically square they should face north, east, south, and west; if oblong,

one long face may be directed towards the south-west. The playgrounds for boys and girls should be separate.

Material.—The buildings should be solidly constructed of stone or brick. Occasionally hollow walls of brick are employed, in which case the outer lining should be 13 inches thick, and the inner $4\frac{1}{2}$ inches, with an air-space of 2 inches

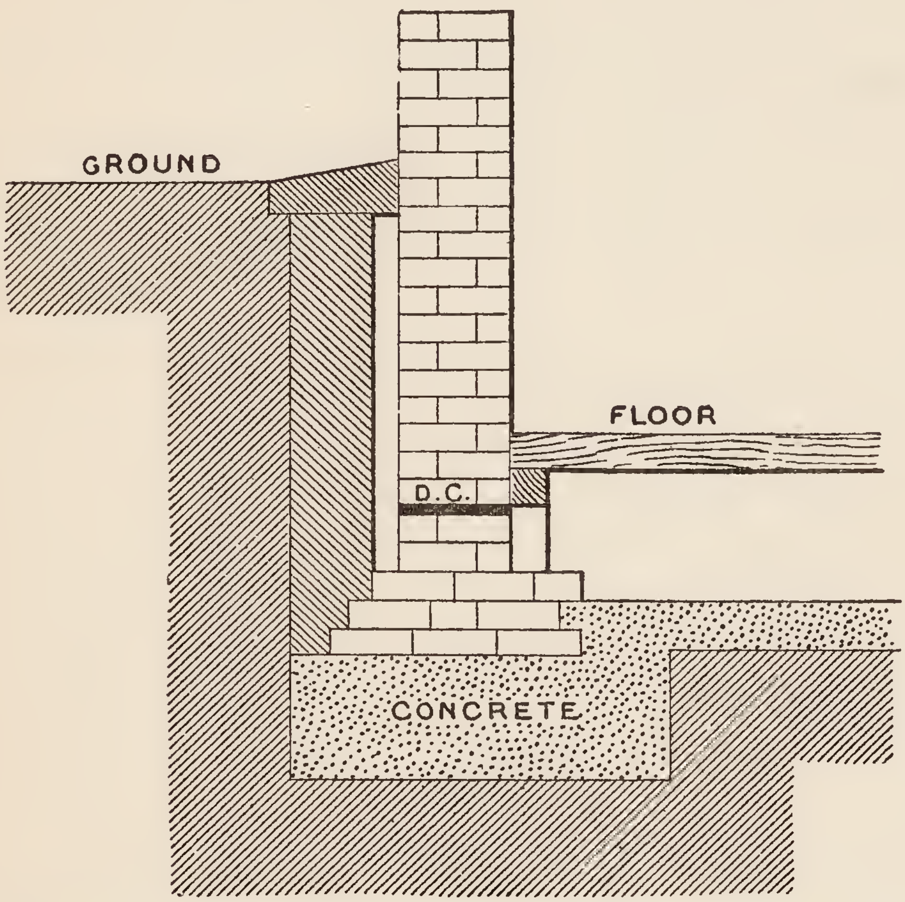


Fig. 23.—Section of Wall, showing Concrete Foundation, Damp-proof Course, Dry Area, &c.

between. Proper damp-courses should always be inserted at the foot of the walls to prevent damp rising.[1]

General Arrangement of Rooms.—In the majority of new schools there is a large central hall, which subserves various useful functions. It contains a large volume of comparatively fresh air, and it serves for drill, marching exercises, and for sorting children into groups for any special purpose. It is generally made to reach right up to the top of the building, and

[1] A damp-course is a layer of slate, asphalt, concrete, or similar impervious material laid in the lower part of a wall to prevent water rising by capillarity (fig. 23, D.C.).

the stairs ascend at the sides or at each end of it.[1] The hall should possess a definite maximum area, viz., not more than 4 square feet for every pupil for which the school is recognized. On the ground floor the class-rooms open directly from this hall, while on the first and subsequent floors it is surrounded by corridors on to which the class-rooms give. If in large schools there is no central hall there should be wide corridors, preferably 12 feet in width, from which the rooms open. In small schools we may have one large school-room with one or more small class-rooms attached. Where the school-room is the principal room in the school, with neither central hall nor wide corridors, it should not be designed for more than 100 pupils.

Sites in cities are, unfortunately, expensive, otherwise it would be an advantage to have all the rooms on one floor. As it is, most large schools have three floors. The stairs, built of stone, ascend at each end of the hall. Each step should be about 13 inches wide, with a rise not exceeding 6 inches. No triangular steps or "winders" should be used. There should be separate stairs for the different sexes, and the staircases should be more spacious than would ordinarily be necessary, in order to permit of easy exit in case of fire or panic.

Cloak-rooms and Lavatories.—It is essential that proper places be provided in which hats, topcoats, and cloaks can be hung. The cloak-room should have separate doors for ingress and egress, so as to prevent confusion. It should be well lighted, ventilated, and warmed, for the purpose of drying damp garments. Between the hanging-rails there ought to be gangways at least 4 feet wide. The hat-pegs should be 12 inches apart, arranged in two tiers, the pegs in any given row alternating with those above or below it, so that we never have two adjacent pegs in the same vertical row. The space

[1] In a large new school recently visited by the writer there are two central halls. One reaches from the ground floor to the top of the second storey, while the other, commencing on the third floor, extends to the roof of the building. This is an advantage, as, with the large amount of attention given to physical exercises and drill, one hall is now scarcely enough for a large school.

(lateral) for each garment is thus 6 inches. The rails are usually made of wood, there being, as a rule, an open space between them. It is a good plan, however, to have these spaces between adjacent rails filled in with wide-meshed iron netting, as by this means contiguous garments are slightly separated. Stout gas-piping covered with aluminium paint makes a bright and neat material for the rails and hooks.

In the same room are the hand-basins. The best arrangement is to have a long shallow white-ware trough running along one side of the room, placed at suitable height and subdivided into a number of small compartments by shallow cross-ridges. The water is admitted into each subdivision at the same time, being turned on (by means of a key) by the janitor at the beginning of each interval, and turned off at the end. The water runs across the basin, escaping by a waste. There are thus no taps or waste-pipes or plugs which the children can put out of order. Beyond the row of basins should be a ledge for soap, and sufficient proper absorbent towels ought to be provided. To meet those cases where a child with dirty hands is sent out of class to wash them, a single basin with ordinary tap should be provided. In the cloak-room there should be a lock-up slop sink, tap, and cupboard for brushes, &c., for the attendant.[1] There must be proper ventilation and disconnection between the cloak-rooms and the rest of the school, in order to prevent the latter being invaded by the disagreeable odour of damp garments, &c.

Class-rooms.—These should approximate a square in shape, long narrow rooms being undesirable. The width should be proportional to the length, and in general should not exceed 25 feet, or be less than 15 feet (Scotch Code). Except in very small schools, a class-room should not be designed for fewer than 24 scholars (English Code); the minimum size should be 18 feet by 15 feet (Scotch Rules). The average number of

[1] A good plan, in use in the Cuthbertson School in Glasgow, is to have the cloak-rooms provided with two doorways fitted with collapsible iron doors. These are locked as soon as the classes go in. The single basin is placed just outside the cloak-room, to be accessible at any time.

pupils per room should be 50 to 60, and no room should ever be designed for more than 80 (Scotch Code). No room can be approved when designed for more than 60 pupils if it be lighted from one side only. It is a good plan to have at least several of the class-rooms so arranged that they are separated only by movable partitions. In a small school one large school-room may be provided, with one or more small class-rooms. If a school has but a single room, the area of this should not exceed 600 square feet.

Floor-space per Scholar.—For infants the English Board allows 9 square feet per child, and for bigger children 10 square feet. If there be no central hall or wide corridors, more is required. For higher elementary schools 16 square feet per head is allowed where there are dual desks, and 13 square feet if the desks be single. In secondary schools 18 square feet per head is the allowance. What one should aim at, is to let every child in a public elementary school have a floor-space of 15 square feet. According to the Scotch Code, a minimum of 10 square feet per child must be granted, but it is often desirable to have more.

Floors, Ceilings, and Walls.—Floors are best made of hard, narrow planking. The walls ought to be finished in some hard material, such as distemper, so that they can be easily cleansed. They should be tinted in some quiet restful colour, such as a light grey-green, and should present as few projections and recesses as possible, as the latter collect and harbour dust. The walls of every room used for teaching, if ceiled at the level of the wall-plate, must be at least 12 feet high from the level of the floor to the ceiling; if the area exceed 360 square feet, the ceiling must be 13 feet high; and if the area exceed 600 square feet, then 14 feet in height. It is of value to have the roofs impervious to cold and heat. Those open to the apex are not approved.

CHAPTER IV

General Structure of Schools (concluded)—Windows, Warming, and Ventilating—Desks, Seats, and other Fittings—Cookery—Laundry—Handicraft—Science—Drawing—Teachers' Room—Gymnasium—Baths—Water-supply—Sanitary Arrangements—Playgrounds.

Lighting of Class-rooms.—This is a matter of the greatest importance by reason of the close relationship between bad illumination and defective vision. The vision of school-children has received much attention (but not a whit more than it merits) of late years, and all are agreed that one of the factors which tends to retard the onset, or at least the development, of poor sight is good lighting.

Windows should be large and sufficiently numerous. In the Scotch Regulations it is recommended that the total glass area should be equal to $\frac{1}{4}$th or $\frac{1}{5}$th of the floor area, and certainly not less than $\frac{1}{6}$th. In ordinary rooms, window area $\frac{1}{10}$th of the floor area is often considered sufficient. Cohn recommends a glass area in schools of $\frac{1}{4}$th the floor area, while Morris gives the following formula:

$$\text{Window area} = \sqrt{\text{Length} \times \text{Breadth} \times \text{Height of room.}}$$

The glass should be good, and quite clear, easy to clean and to repair. Sometimes a portion of the lower panes is made of translucent, or frosted glass, to prevent children from seeing passing objects, and so having their attention distracted. This kind of glazing should be avoided as much as possible. "Cathedral" glass blurs outside objects, but lets much more light through.

Windows should be of such height that the sill (lower border) is from $3\frac{1}{2}$ to 4 feet from the floor, while the lintel (top) reaches right to the ceiling. If this is not attended to, a layer of foul air collects between the window-heads and the ceiling. A large portion of every window should be made to open, for purposes of ventilation and cleaning, and this even although a mechanical system of ventilation is in use, for no one can foresee when such a system may not break down.

Where windows are used as the chief means of ventilation, the top part may be constructed to open inwards on a hinge, so as to form a hopper, like the Sheringham valve.[1] It is a good plan to provide suitable blinds (linen).

The best light for a school-room comes from the left. By it no shadow is cast by the hand in writing, upon the paper where

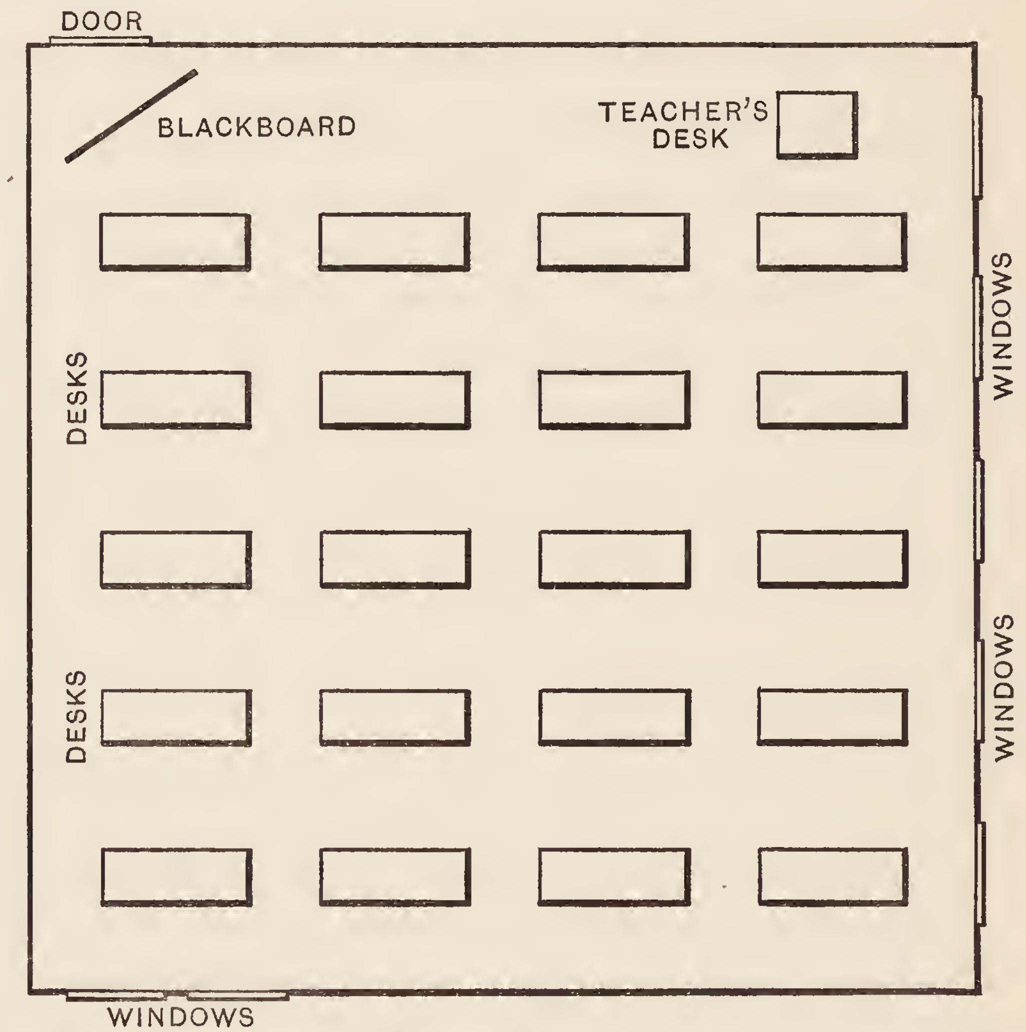


Fig. 24.—Class-room to illustrate Lighting from the right side and from the back

the word is just about to be written. It is not always practicable to get a left light, and in that case right light may be utilized as being next best. In such a case it is a very good plan to have a large window in the wall *behind* the children, and towards their *left* side. In this way some light comes over their left shoulders, and, by illuminating the paper from that side, tends to neutralize any shadow cast by the hand in writ-

[1] In some schools there is a projection at the bottom of the window instead, to direct the air upwards when the lower sash is raised.

ing (fig. 24). Front light is objectionable. It is very trying to the eyes, as they are dazzled, and the object looked at is poorly illuminated. Roof light should not be used. According to both English and Scotch Codes, sky-lights are only permitted in central halls and main corridors having ridge- or apex-ventilation. The writer sees no objection to the use of roof light in physical and chemical laboratories, and in cookery and laundry class-rooms. It is also useful in gymnasiums, workshops, and swimming-baths.

The windows of a school-room cannot afford really good illumination beyond a certain distance. Suppose they are placed along one side of a fairly square class-room, the distance from the window-wall to that opposite it must not exceed 25 feet as a maximum. The rows of desks should be placed across the room, that is, at right angles to the windows; and it is a good plan to place them so that they are not opposite the windows, but alternate with them, as is the case with beds in a hospital ward. In all cases, windows should be severely plain; they are for the provision of light, not for ornament, and the wood-work of the sashes should have as little moulding and grooving on it as possible, to prevent the lodgment of dust. Where artificial light is required, electricity should be used if available (see p. 52).

The Warming of Class-rooms.—One aims at the maintenance of a suitable and an equable temperature—from 56° to 60° Fahr. Evenness in the temperature prevents draughts. While guarding against cold, one must not run to the opposite extreme and allow the class-room to become too hot, as this soon affects the sensitive nervous system of the child. An easily-read thermometer should hang in every class-room. It is very suitable to employ hot-water pipes for warming schools. A low-pressure system, as described in Chapter III, should be used, and the heat disseminated by direct radiation. By this means the main corridors and the central hall are also kept warm, and an equable temperature is thus more easily kept up in the class-rooms, and internal draughts avoided. An open grate, in addition, may be placed in each room, both for the

purpose of extra warming and for the value of the flue in ventilation at all times. Open fireplaces should have suitable guards.

The advantages and disadvantages of stoves have been already considered. The Codes of both England and Scotland deprecate their use. They are only approved when—

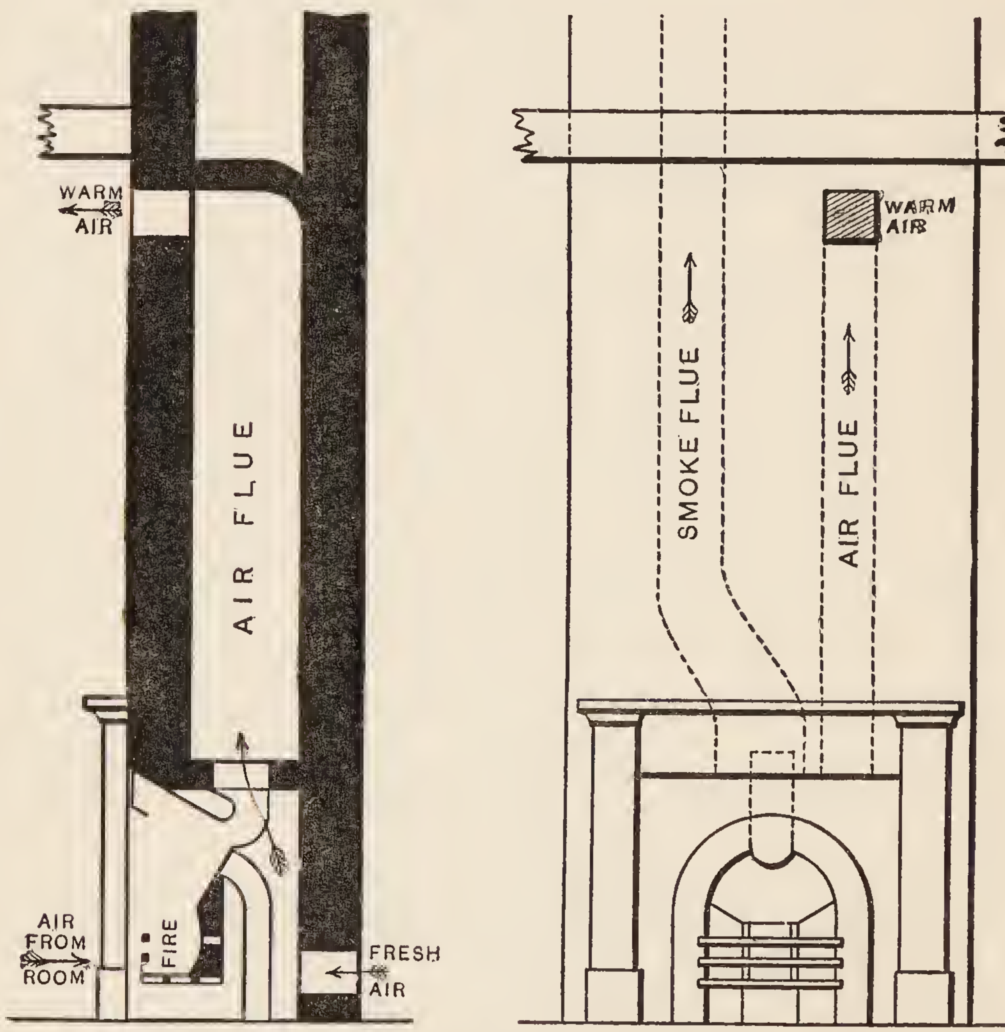


Fig. 25.—Galton's Ventilating Fireplace

(1) Provided with proper chimneys (as in the case of open fires);

(2) Of such a pattern that they cannot become red-hot, or otherwise contaminate the air;

(3) Supplied with fresh air, direct from the outside, by a flue of not less than 72 inches superficies; and

(4) Not of such a size or shape as to interfere with the floor-space necessary for teaching purposes.

Open grates may be employed. They should be placed

(English Code), if possible, in a corner of the room, so as to leave space for the teacher's desk and black-board. The Scotch Board recommends that where open grates are used they should be of the ventilating pattern, that is, having an air-chamber surrounding the lower part of the chimney, and communicating on the one hand with the outer air by a fresh-air inlet, while on the other, openings are provided leading to the room (see fig. 25). Fresh warmed air is thus delivered into the room, and the openings through which this air passes may be controlled by valves or sliding gratings, so as to regulate the air-supply. These air-chambers ought to have proper means of access for the purpose of cleaning.

Ventilation.—The aims and principles of ventilation have been discussed with some fulness already. It will suffice here, to indicate the recommendations of the Education Departments, to say that the great aim is to prevent stagnant air in the class-rooms. Even where windows are fully utilized for ventilation there must be a provision of additional inlets and outlets. The latter should be placed near a warm flue, in order to assist the outward trend of the current of impure air. The Scotch Board recommends that outlets should have motive power by means of heat or exhaust, otherwise they may act as cold inlets. A good form of outlet is a separate air-flue built for each room, and carried up in the same stack with the smoke-flue. Its proximity to the latter warms the contained air and keeps it always moving upwards, and so outwards. The minimum size of outlets should be 4 square inches per child, and of inlets 6 square inches (Scotch Code). In every case a much larger area of outlet and inlet is required where no motive force is provided.

Inlets should be in corners of the rooms farthest from the door and fireplaces, and should be so arranged as to discharge air upwards into the room. Both inlets and outlets should always communicate directly with the external air, and outlets in ceilings must not open into a false roof, but must be properly connected with some form of extract-ventilator. Gratings in floors should never be used for ventilating. The inrush of

cool air chills the feet and legs of the pupils, and may cause abdominal pain, diarrhœa, and other ailments.

Although lighting from the left is desirable, ventilation demands also the provision of a small swing window as far from the lighting as possible, and near the ceiling; this acts as a ventilator (English Rules). Besides the continuous steady ventilation by means such as those just described, the class-room should be flushed thoroughly with fresh air at every opportunity between classes, by opening doors and windows widely. The admittance of sun-light is important, as it not only aids in ventilation, but exercises a specially beneficial effect on the health of school-children. Dr. Kerr (London County Council) recommends a limit of 1 per 1000 of carbonic acid gas in the air of school-rooms. It will be remembered that pure air has from 0·3 to 0·4 per 1000 of this gas. One should really supply each child with about 2000 cubic feet of fresh air per hour, but it is difficult in practice to provide more than 1500. The entering air should not have a greater linear velocity than 5 feet per second. This is best obtained, according to Haldane and Carnelly, by large low-pressure fans running at a low speed (a Plenum system), and is much aided by an extractor.

Arrangement of Desks, Seats, and other Fittings

The desks and seats in a school should be graduated in size according to the age of the pupils. In the majority of new schools, desks of the dual pattern are in use, but in a number of older schools long desks may be found. All seats ought to be provided with backs, and desks should be placed, as already mentioned, at right angles to the window-wall. The floor of the class-room (Scotch Code) should be stepped, so that the desks rise in tiers towards the back of the room, the maximum height of any rise being 4½ inches (at the back).

The English and Scotch Regulations alike recommend a minimum of 18 inches per scholar in each long desk, and that each such desk should in length be a multiple of 18 inches.

No limit to length is fixed by the English Code, but in Scotland it is recommended that no such desk should exceed 9 feet in length. A desk like this would accommodate 6 scholars. Gangways of 18 inches should be placed at the walls and between the groups of desks, so as to let the teacher pass behind them.

Where the dual desk is used, it ought to have a length of 40 inches. The gangways should be 16 inches wide. The Scotch Code advises 40 inches for the dual desk in the higher standards, 36 inches in the lower, and 30 inches for the youngest infants. Dual desks do not need to be arranged with gangways behind them, as the teacher can easily supervise each child from the side. Another style of desk recently recommended is the "Sheffield" pattern—a continuous long desk with six isolated pedestal chairs placed at it. The children can easily stand in their places between these chairs when required. The advantage of desks of the dual and Sheffield pattern is that the children are not brought into such close contact with one another as in the case of the long desks. Contiguity of children is an important factor in the spread of infectious diseases at school, and any method by which the incidence of the latter can be diminished should be welcomed.

In a small class-room the desks may be arranged so that there are five rows of long desks or six rows of dual desks. If the school-room is designed to hold more than 60 scholars, there should not be more than four rows of long desks or five rows of dual desks, the desks being arranged in tiers one above another.

The top of the desk should be very slightly inclined, say at an angle of 15°, or with a difference in height between the front and back of the desk of not more than 3 inches. A flat desk encourages stooping. No ledge should run along the front of the desk, as it interferes with writing. The front half of the desk may be made to hinge back on the rest, so as to form a ledge at an angle of about 40° to 45° suitable for drawing. Single desks are not necessary in ordinary public

schools (English Code). The edge of the desk farthest from the child should have no projecting rim, so that the child's slate can be pushed up the desk till writing can be done at its lowest part, and yet can always lie on one plane.

The seats, as I have already remarked, should be provided with backs, the latter being a very necessary support for young growing children. The height of the seats from the floor should be graded according to the size of the scholars, and should be about the distance from the sole of the foot to

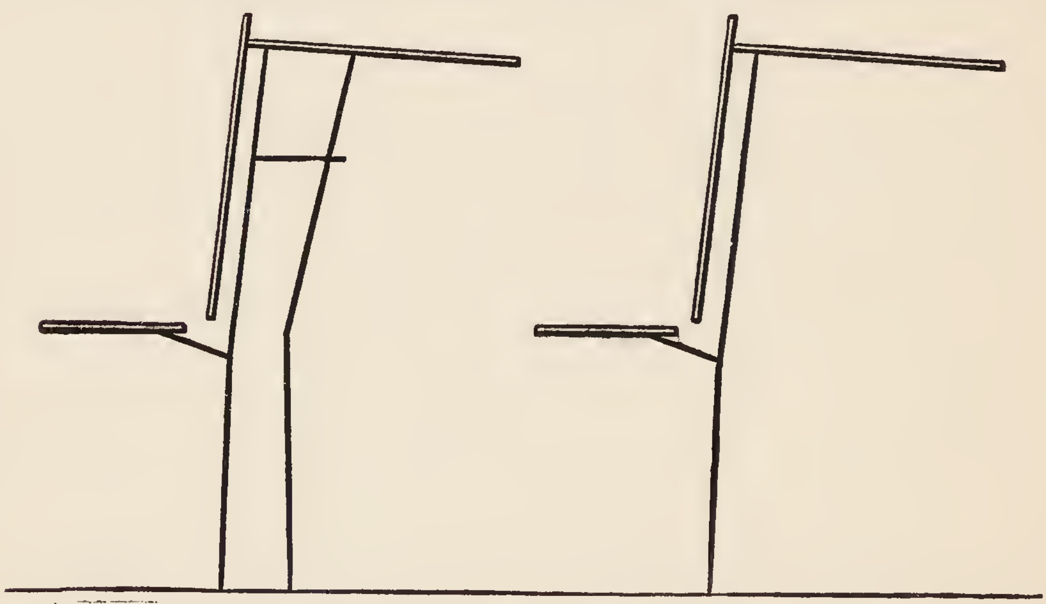


Fig. 26.—Diagrammatic Section of Dual Desk to show relation of Desk to Seat

the knee of the average child in the class.[1] The width should be at least 8 inches. They should be so near the desk that the horizontal distance between the front edge of the seat and a vertical line dropped from the edge of the desk (front) should not exceed one inch (fig. 26). Indeed the Regulations both for England and Scotland recommend that when the desk is used for writing, its edge should be vertically over the front edge of the seat. The height of the front edge of the desk above the seat should be approximately equal to one-sixth of the scholar's height. Each seat should be hinged

[1] To meet the cases where a class may contain children much above or below the average height, the Anglo-Swiss adjustable desk, or a desk with some form of adjustable seat may be used. In any case the child when sitting erect should have the eyes not nearer to his book than 10 inches.

so that it can be lifted, and it is a good plan to have the desk made so that it can be tilted too. In this way cleansing of the floor is more easily accomplished.

As regards the fittings of the class-rooms, a dull black-board of glass with a black background is very suitable, though black-boards of wood or of slate are still much employed.[1] The use of slates for children should be discontinued. They are without doubt a means of spreading infectious disease, especially when cleaned (as they often are, in spite of warning and watching) by the users spitting upon them or licking them. Instead of slates for sums, dictation, and so forth, paper should be employed. This could be provided at a reasonable low cost in blocks like sketching-blocks, and although the cost would certainly be higher than that of slates, one must put against this the diminution of infectious disease and consequent better attendance that would result. Some authorities recommend that a low black-board should be fixed all round the room for free-arm drawing. The large black-board should never be placed between two windows, but at the end of the room towards which the children face, or in the angle formed by this wall and that opposite the windows. The walls should be of a quiet restful colour, and ought not to be covered over with maps, as these simply harbour dust. The latter should be in a proper cupboard along with chalk, dusters, and other teaching apparatus. There should be a teacher's desk and chair, and perhaps a spare chair. A small square wooden box for waste-paper is a convenience, and serves to keep the room neat.

Infant Schools

The only point that requires special mention is that infants' schools and playgrounds should always be on the ground floor. No school-room should have more than 80 infants in it. The space per child in a long desk should be 16 inches, and a dual desk for infants should measure 30 inches. As there is more

[1] A good black-board is the Darlington, which is very easy to write on.

done by object-lessons than by writing, the light from the right is practically as good as that from the left.

Special Departments

These include Cookery, Laundry, Handicraft, Science, and Drawing, and may each be considered briefly. In some cases a single room for these departments will serve for more than one school, if provided as a Centre in a suitable position. Each such Centre ought to have its own lavatory and cloak-room.

1. **Cookery.**—The cookery-room may be inside the main school building, either at the top or in the basement, or in an annexe—the latter being very suitable when it is a Centre. The English and Scotch Codes both recommend that a Centre should accommodate 12 to 18 children for practical work, or 36 to 54 for demonstrations, at one time. The larger size means a room of 750 square feet superficies, or 10,500 cubic feet capacity. There should be provision for teaching scullery-work. In one excellent school with which the writer is acquainted, the accommodation is as follows: a cloak-room placed opposite the entrance door, a large practical room (kitchen) on the left hand, with an excellent scullery off it, and on the right side a large demonstration room provided with a gas cooking-stove. The sink should be in full view of the teacher and children, and provided with a cold-water supply and waste-pipe. It is advantageous that it have a hot-water supply in addition.

The floor-space should be kept free from stoves, tables, &c., as far as possible, and for every scholar a space of 20 square feet should be provided. These rooms are very apt to become too warm, with consequent risk of chill to the pupils when they go into the fresh air again. The temperature should not be allowed to rise above 70° Fahr., and some form of exhaust may be used with great benefit, such as a fan, to rapidly remove the heated air. Where a gas cooking-stove is employed, as it frequently is, it may be necessary to have a

special pipe in connection with it to carry off noxious fumes. All the stoves and fireplaces and apparatus generally used in cooking should approximate as nearly as possible to what would be found in the home of the ordinary working-class family.

2. **Laundry.**—It is recommended in both the English and Scotch Regulations that a Laundry Centre should always be an outside building, and one can see that this is advisable owing to the production of steam necessarily associated with this kind of work. The room should be as simple as possible, have a floor area of 750 square feet, and be provided with a gallery or raised platform, with desks for 42 children. The laundry tables should be large, of such size as to allow at least 3 feet of space for each child when ironing. Special arrangements require to be made for the ventilation of laundries so as to remove the steam properly. In small schools a combined room for cookery and laundry-work may be approved (Scotch Code).

Dressmaking is a special department, in a way, but no Regulations are laid down regarding it by the Boards of Education, as the teaching of it requires no special considerations with regard to the pupils' health. All that is required is an ordinary room of reasonable size, adequately lighted and ventilated, and provided with large square tables for cutting out.

3. **Manual Instruction (Handicraft).**—The room devoted to this may be very suitably built outside, like that used for laundry-work. This department should be arranged more on the lines of a workshop than of a school, for it is essentially the former though instruction is given in it. It should be simple in arrangement, well lighted, and not kept too warm, as the occupants are engaged in bodily exercise, and are consequently keeping themselves warm. Windows on the right or left side, or on both, are quite suitable, and roof light is, in my opinion, quite admissible. The only objection to be urged against the latter is that the roof-glazing may make the room too hot in summer. This objection has not much force in Scotland. Working-benches of sufficient breadth cross the

room, and are provided with racks for holding tools. At one end there may be a raised platform for the instructor, and, behind and above this, proper space for storing wood. The English and Scotch Regulations agree in stating that the height at the windows in front of the benches need not be more than 10 feet. A flat ceiling is not usually necessary. Ample ventilation should be provided by inlets 5 feet from the floor, and by outlets at the highest point. It is recommended that a room for 20 scholars have a floor-space of 700 square feet; it must be remembered that much of this superficial area is taken up by the working-benches.

4. **Science Room.**—Both Codes agree in recommending that a room, properly fitted up for the teaching of elementary practical work in science, may be provided for the use of one large or several contributory schools. Such a science room should not, as a rule, contain less than 600 square feet of floor-space. In the writer's opinion it should be placed on the top flat of the building. It should be fitted with plain strong tables, sinks, cupboards, and shelves, and provided with a proper supply of gas. Where necessary a fume-closet may be provided, that is, a closet built in an outer wall, communicating directly with the outer air by means of a ventilating shaft, and closed on the room side by a sliding glass door. In this, chemical operations are carried on which entail the production of noxious fumes.

5. **Drawing Class-rooms.**—Both in England and Scotland, a drawing class-room can only be sanctioned where it is likely to be used for a reasonable time every week by the scholars from one large school or several small contributory schools. A suitable size for such a room is 600 square feet of floor-space. Light should be admitted at a suitable height and angle from the north, north-east, or east. The English Code in addition recommends that the whole of the available wall-space of the room, from a height of about 3 feet above the floor up to a height of about 7 feet, should be covered with linoleum, or have the surface suitably prepared for the purpose of chalk drawing. Where no special drawing class-room is

provided, the walls of at least one of the ordinary class-rooms should be prepared as described above.

Teachers' Rooms.—In the Codes it is laid down that in large schools there should be provided for the use of teachers a small room or rooms, with suitable lavatory accommodation. Further, that a store-room for books and other school material should adjoin the teachers' room. In the writer's opinion a satisfactory arrangement is to have (1) a headmaster's room, with lavatory adjoining, and next it the store-room for school material; (2) a room for female teachers, with lavatory; and (3), the same accommodation for male teachers. Each of these rooms is greatly enhanced in comfort if it be fitted with an ordinary open fireplace. Each should have a press, and each should be provided with a small gas-cooker, where water may be boiled, or tea, coffee, and cocoa heated up. One must remember that teachers, in many instances, are at school all day, their homes being so far distant as to render a mid-day visit impossible, and that their occupation is always arduous and trying. This being the case, as much should be done as is reasonable to render their times of rest pleasant and refreshing.

The Gymnasium.—This is best as a Centre for several schools, and placed in an annexe apart from the main building. It should be a high and spacious room; one 45 feet by 30 will answer well, and it might have side and roof light. Like a workshop, it does not require to be heated to the same temperature as a class-room. The floor should be of wood blocks, and the walls may be tiled to a height of 4 feet 6 inches from the floor. The usual furnishings of a gymnasium will, of course, be provided, with racks along the walls for holding Indian clubs, dumb-bells, single-sticks, and so on.

School-Baths.—It is very desirable that swimming-baths should be provided for children in elementary schools, and for this purpose one bath can be established as a Centre, being erected within the playground of one school, and utilized by the pupils of that and of other schools. The tank should be 75 feet in length by 30 feet wide at least, with a depth ranging from $2\frac{1}{2}$ to $4\frac{1}{2}$ feet. Proper dressing-boxes should

be provided, and a bathman, who is also the instructor in swimming, must be present daily. A gallery may be erected for the convenience of visitors when competitions take place. These latter form a very wholesome stimulus to the boys and girls to try to excel in what is a very valuable accomplishment, and a most useful form of physical exercise. One or two days a week should be kept for the girls. The bath-water may be changed twice a week.

Dr. Kerr of the London County Council, in the report of the Education Committee issued in December, 1905, recommends that school baths for cleansing the children should be provided quite apart from swimming-baths, owing to complaints that children have become infected with vermin from using public baths. He goes on to say: "For cleansing purposes a very shallow tank 6 inches deep, with a rose for a shower over each child, is used, worked by a chain which the child pulls when under the rose. In some German schools the shallow tank is provided; others have a somewhat raised flat part, with a gutter of white tiles round, about 1 foot broad and 6 inches deep. In a recently-provided school the bath-room was square, with a sloping concrete edge run round, and on this twenty ordinary galvanized slipper-baths arranged, into which each child got before working the shower. All these devices are intended to economize room, to save expense in heating, and in cost of water. With the campaign now being carried on in favour of personal cleanliness in schools, the provision of school washing-baths, as distinct from swimming arrangements, is becoming increasingly necessary in many parts of London."

The warming of these large baths may be accomplished by a pipe conveying steam from a boiler. If the school is warmed by a Plenum system, the boiler which raises steam and hot water for heating the air will also provide a pipe for the baths. If not, a separate boiler must be installed. A hot-water pipe may run round the bath, passing under the seats in the dressing-boxes, and so keeping the air from being chilly as the children dry and dress themselves.

Water-Supply.—The Regulations of both English and Scotch Boards with regard to water in public elementary schools are the same, and are as follows:—

1. All schools should be provided with an adequate supply of wholesome drinking water.

2. In cases where there is no public supply in the district, care must be taken to ascertain that the supply proposed to be adopted is adequate in quantity, is of suitable character, and is not liable to pollution in any way, as, *e.g.*, by surface drainage, or by leakage from sewers, drains, cess-pools, or other receptacles.

3. All water-pipes should be properly protected from frost, and so laid or fixed that in the event of their becoming unsound, the water conveyed in such pipes will not be liable to become polluted or to escape without observation.

4. There should be no direct contamination between any pipe or cistern from which water is drawn for domestic purposes, and any water-closet or urinal.

5. All water-closets and urinals should be provided with proper service cisterns, which, together with the outlet therefrom, should be capable of providing a sufficient flush.

6. Any cistern to be used for the storage of water should be properly covered and ventilated, and so placed and constructed that the interior thereof may be readily inspected and cleansed.

These rules are clear and thorough, as indeed they ought to be, seeing that water is one of the primitive necessaries of life, and one which should be provided in a thoroughly pure state. Contamination of drinking water by sewage may cause outbreaks of such serious illnesses as typhoid fever, dysentery, and even cholera. Everyone must have noticed how frequently children ask for a drink of water. They do so because they are thirsty, and thirst is simply the cry of the bodily tissues for water. That we need to take much fluid daily is not to be wondered at, seeing that 64 per cent of our body-weight is water. Children lose much fluid in perspiration, and want much to make up this loss. It is therefore all-important that the supply be pure.

Sanitary Arrangements

It is of course important that the sanitary arrangements of a large school be up-to-date, and in harmony with modern ideas on the matter. The main points of importance laid down by the educational authorities are:—

1. Water-closets within the main building are not desirable, and should only be provided for teachers. The others should be a short distance from the school, and totally disconnected from the latter.

2. The latrines and approaches thereto must be separate for boys and girls. Boys and girls should not use the same passages, and where this is unavoidable, there should be complete supervision from the class-rooms by means of sheets of clear glass.

3. Net size of the interior of the closet, as regards width, should be not less than 2 feet 3 inches nor more than 3 feet. The interior should be fully lighted and ventilated, and the door cut short at both top and bottom. The English Rules recommend that the door be short at the bottom by 3 inches and at the top by 4 inches; in Scotland the recommendation is that it be docked of 4 inches both top and bottom. Only one seat allowed in each closet.

4. Where the teacher's house is in the school-yard, the children should not be obliged to pass in front of it to reach the lavatories.

5. The following table shows approximately the number of closets required:—

A. ENGLISH REGULATIONS (1905).

	For Girls.	For Boys.	For Infants.	For Girls and Infants.
Under 30 children	2	1	2	2
,, 50 ,,	3	2	3	3
,, 70 ,,	4	2	3	4
,, 100 ,,	5	3	4	5
,, 150 ,,	6	3	5	6
,, 200 ,,	8	4	6	7
,, 300 ,,	12	5	8	8

B. SCOTCH REGULATIONS (1906).

	For Girls or for Girls and Infants.	For Boys.	For Infants.
Under 30 children	2	1	2
„ 50 „	3	2	3
„ 70 „	4	2	3
„ 100 „	5	3	4
„ 150 „	6	3	5
„ 200 „	7	4	6
„ 300 „	8	5	7

6. As regards urinals, the recommendation is that the channel be in the proportion of 10 feet lineal per 100 boys, with a sufficient supply of fresh water for flushing and proper drains.

The English Code also makes rules for the provision of earth- or ash-closets of an approved pattern for rural places. If they are used, separate drains for the disposal of surface- and slop-water are necessary. Privies and cess-pools should be discountenanced, and where absolutely requisite, should be at a distance of at least 20 feet from the school.

In all cases it should be the duty of the school janitor to very strictly supervise all the sanitary arrangements, and to see that their use is attended with no abuse of any kind.

Playgrounds.—At the beginning of this chapter, under the heading " Site and Aspect ", mention was made of the area of playground required, which is about one-quarter acre for every 250 scholars. This should be irrespective of the site required for a teacher's or caretaker's house, or for a cookery or other centre. A minimum open or unbuilt-on space of 30 square feet per child should be preserved.

Except where the schools are very small, there should be separate playgrounds for the boys and girls, with, if possible, separate entrances from the road or street. The infants' playground should be on the same level as the school, and a sunny aspect is very important here.

All playgrounds should be fairly square, properly levelled,

drained, and enclosed. When the Codes say "levelled", that does not imply that the surface is to be a dead level. What is aimed at is a very gentle slope towards a central or lateral gutter, so that rain-water may be quickly drained off. A portion should be covered, having one side against the boundary wall. It is a good plan to place a low stout bench along the wall in the playgrounds for infants, under cover. No covered way should connect the offices with the main buildings. The surface of the playground should be concrete, very slightly marked in dimples, which prevents slipping. Buttresses, corners, and recesses on the main building should be avoided. In some cases a swing of some kind is erected in the playground. The ropes, &c., connected with this should be tested daily by the janitor in case accident occur. A tap for drinking water, with metal cups, should be provided.

This concludes our somewhat full consideration of the structure and arrangements of public elementary schools in England and Scotland. Much attention has been devoted by educational authorities to this subject, and in general it may be said that the Codes embody recommendations in harmony with the latest teaching of sanitary science. The English Board publishes regulations for secondary schools as well, but there is no similar code in Scotland.

CHAPTER V

The Health of the Child—General Nutrition—Classes of Food-stuffs—Their Uses—The Physiology of Digestion—The Normal and Underfed Child—Bad Feeding—Rickets—Determination of Height and Weight as Indices of Physical Development—Provision of Meals for School Children.

The maintenance of health in the child demands that an adequate supply of suitable nourishing food be given daily. All bodily processes are very active during the early years of life, and not only must enough food (and proper food) be taken to supply the waste which these active processes en-

gender, but in addition there must be sufficient to add to the actual structure of the body,—to build up and increase the bulk and the weight of bones, muscles, and internal organs.

Classification of Food-stuffs

There are two foods which, in a sense, may be regarded as perfect, as complete in themselves, for at least certain stages of development of the animal body. These foods are the egg and milk. The former is able to supply all that is requisite to produce the entire body of the young bird, while milk yields all that is necessary for the growing mammal in the first months of life. Chemical analysis of these foods shows that they are composed of five classes of food-stuffs, which must therefore be regarded as the essentials of a perfect dietary. These classes are:—

1. Proteids.
2. Fats.
3. Carbohydrates.
4. Mineral matters.
5. Water.

These groups require some detailed consideration.

1. **Proteid Foods.**—These are composed of the elements carbon, oxygen, hydrogen, and nitrogen, with, in some cases, small amounts of sulphur and phosphorus in addition. It is the presence of nitrogen which is characteristic of these foods, and so they are sometimes called "nitrogenous foods". They embrace many articles of daily food of much importance, such as the lean (or muscle) of beef, mutton, pork, bacon, and fowl; a large part of the egg; an important constituent of milk (caseinogen) and of cheese; and in general what we term "meat foods". Proteids are also important constituents of many vegetable foods, such as wheat, barley, oats, peas, beans, lentils, and so forth. Since white of egg or albumin is a typical example of a proteid food, these foods are sometimes also called "albuminous".

2. **Fats.**—Foods of this class are composed only of carbon, hydrogen, and oxygen, and the first two elements are in excess of the latter. Fats occur in the animal and vegetable kingdoms; in the former we have the fat of beef, mutton, and bacon; the fat of certain fish, as the herring; the cream of milk, and the butter made from it; and the fatty part of the yolk of eggs. Many vegetables yield fat, such as olive-oil and cocoa-nut oil, and fat occurs in all the common cereals in daily use, such as wheat, oats, and barley.

3. **Carbohydrates.**—The foods in this group consist, like the fats, of carbon, hydrogen, and oxygen, but the proportion of these elements differs from that in fats, there being always in a carbohydrate molecule exactly twice as many atoms of hydrogen as there are of oxygen, while the carbon atoms are usually about the same in number as the oxygen. They therefore always contain a greater percentage of oxygen than the fats do.

Carbohydrates are divided into two sub-groups: (*a*) *Saccharine foods*, and (*b*) *Starchy foods.* The saccharine foods include ordinary sugar (from the cane or the beet), the special sugar of milk (lactose), the sugar of grapes and raisins (dextrose), and malt sugar (maltose). The starchy foods contain starch, an important constituent of flour, oatmeal, potatoes, rice, corn-flour, sago, tapioca, and a host of other farinaceous foods (Lat. *farina*, starch). In this sub-group are also cellulose—an important constituent of the stems of vegetables, and various gums.

4. **Mineral Matters.**—These include common salt (chloride of sodium), phosphates of sodium, potassium, calcium, and magnesium, compounds of iron, and various other mineral bodies. These occur in varying quantities in nearly all foods, such as beef, mutton, milk, eggs, cereals, vegetables, farinaceous foods, and so on; we usually take in the mineral elements of our food in mixed food-stuffs, the only one commonly taken in a pure form being common salt.

5. **Water.**—This, composed of hydrogen and oxygen, also occurs in all mixed foods. It is present in some in very large

quantities, for example, in potatoes and turnips. It is essential for health, and constitutes no less than 64 per cent of the total weight of the body.

To these five groups we may add another, that of the so-called "food accessories", such as tea and coffee, and condiments (pepper, mustard, spices). They are perhaps not absolutely essential, but they play a part of some importance in our daily dietary.

Functions of the various Classes of Food-stuffs

1. **Proteids** are essential for the total daily processes of life. Repair cannot go on in their absence, nor can organs or muscles be increased in size or in strength. They are required for all the chemical activities of the body—the general "metabolism" as it is termed—for the secretion of all the digestive juices, and indeed for the working of the whole machinery of life. They are needed to build up and maintain brain and nerves, muscles and skin, heart and lungs, and indeed all parts of the body. It has been said that the body of the child is a scene of great activity, and it will therefore be at once apparent that an adequate supply of proteid food is an essential.

2. **Fats are great heat-givers.**—It has been mentioned that they contain little oxygen, and it may be added that they are greedy for more, combining with it when they can, and giving out much heat in the process. Absorbed fat thus meeting with oxygen in the body is burned off, and this combustion is one of the great sources of animal heat. The heat-value of fat, weight for weight, is almost double that of proteid or saccharine, or starchy food. In all cold climates there is an instinctive desire for fat to maintain the body-heat, and in winter, for this reason, school-children require an adequate supply of it. Fat also, as such, goes to form part of the framework of the body, being deposited under the skin, among the muscles, and around various internal organs to support and protect them.

3. **Carbohydrates.**—All the starch we take in food becomes

sugar of a special kind (grape-sugar or dextrose) before it is absorbed into the body, and the same is true of the saccharine foods. These foods are of value in two ways: by union with oxygen they give out heat, and so aid the fats in keeping the body at a proper temperature, and secondly, in a similar way, their chemical energy is converted into mechanical energy, and so they aid us in performing work. Sugary foods, in a modified form, constitute a part of our muscles, and being used up there they yield muscular energy.

4. **Minerals and Water** are necessary, partly to build up the frame of the body, the former entering largely into the composition of bones and teeth, and occurring also in practically all the organs. Various salts and water, too, are essential for the secretion of various fluids of the body, such as saliva, gastric juice, and so forth, while water also acts as a vehicle to carry away waste material dissolved on it.

5. **Food Accessories.**—These, in the form of tea or coffee, act as an agreeable stimulus to the nervous and muscular systems, and are perfectly safe when taken fresh and in reasonable quantities. The use of them is practically universal, but their employment in the early years of life is to be deprecated. They are, unfortunately, used only too much during school years, to the exclusion of more suitable foods. Various condiments are used in preparing and serving food, and, in strict moderation, tend to make it more palatable, and in some cases improve the appetite. But the healthy child requires no stimulus beyond hunger.

Short Account of the Physiology of Digestion

Food taken into the mouth is first chewed or "masticated", being divided into small fragments by the sharp cutting teeth, and reduced to a pulp by the grinding teeth (fig. 27). It is constantly moved about by the tongue, and is thoroughly moistened by the saliva. This fluid is one of great importance. It is poured out (secreted) by three pairs of glands, and not only serves to moisten the mouthful of food, but is able to act

chemically on one food-stuff, viz., starch. In virtue of a ferment in it named "ptyalin" it can change starch into malt-sugar, and this constitutes the first of the digestive processes, which have as their aim the physical and chemical alterations of the food necessary for its absorption into the body (fig. 28). It should be remembered that children masticate somewhat poorly with their first or milk-teeth, those that must serve them chiefly for the first nine years of life. They are therefore apt to bolt their food, and if a teacher happen to be beside children when they are eating, care should be taken to inculcate on them the necessity of slow eating and thorough chewing.

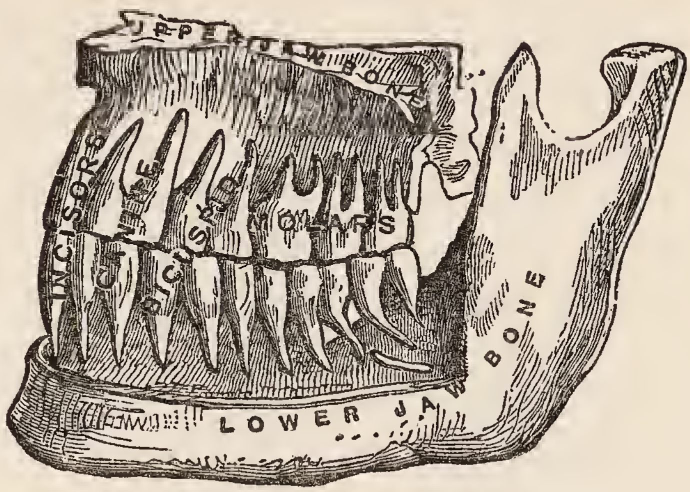


Fig. 27.—Side View of Jaw with Permanent Teeth Bone cut away to show their roots.

The bolus of food is at length transferred to the back of the mouth and throat, grasped by the muscles there, and passed into the gullet or *œsophagus*, a tube with muscular walls extending from the back of the throat to the stomach. The food-mass does not drop down this like a stone thrown into a well,—it is handed down leisurely by the muscular walls, and so reaches the stomach. The latter is a muscular bag, roughly speaking pear-shaped, lying largely under cover of the lower ribs of the left side, in the concavity

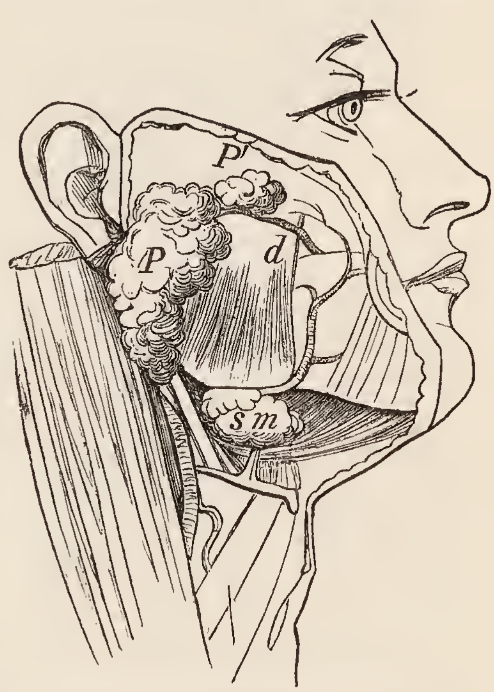


Fig. 28.—The Salivary Glands

P P', Parotid; *sm*, submaxillary. *d* is placed below the duct of the parotid.

of the diaphragm (fig. 29). Its interior is lined with a mucous coating containing innumerable glands (fig. 30). The food received into the stomach is moved backwards and forwards, round and round, and reduced to a pulpy mass called *chyme.* During this stage (the stage of gastric digestion) the glands on the stomach wall are pouring out their secretion, and in it we find two ferments, *pepsin* and *rennin,* and an acid, *hydrochloric acid.* The pepsin, aided by the acid, acts on meat-foods, changing them into a soluble form named *peptones.* This is the *peptonization of foods,* and it converts proteids into a state suitable for their absorption into the body. The rennin or second ferment of the stomach is very active in young mammals still living chiefly on milk, and it curdles the proteid of the latter—the soluble *caseinogen,* — changing it into insoluble *casein,* which, with the fat of milk entangled in it, constitutes curd. Fat itself is not altered or digested in the stomach, and the salivary action on starch, commenced in the mouth, soon ceases in the stomach, as the ferment of saliva cannot act beside an acid.

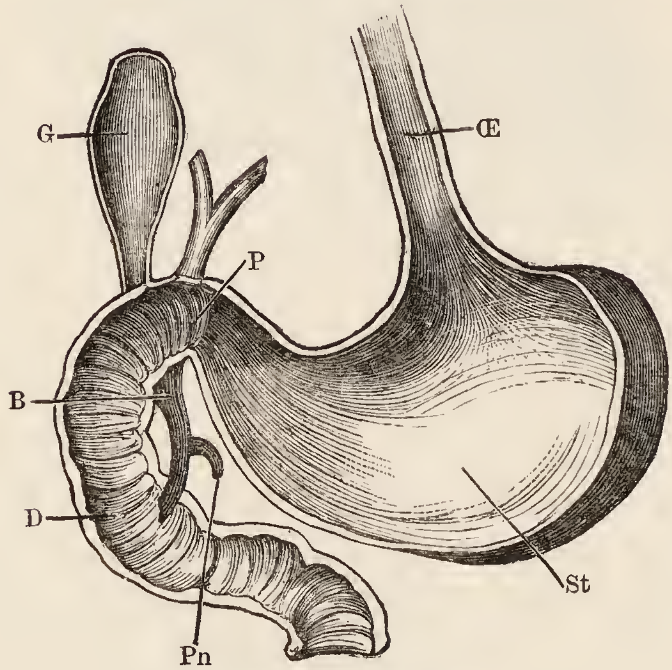


Fig. 29.—Stomach, &c.

Œ, Gullet; St, stomach; P, pyloric opening; D, duodenum; G, gall-bladder; B, bile-duct; Pn, pancreatic duct.

The stomach, as we have seen, has at one end the opening of the gullet, at the other there begins the small bowel or *intestine.* The orifice of the latter at the stomach is kept closed normally by a circular band of muscle-fibres termed a *sphincter.* Similar circular bands exist at the neck of the bladder and at the lower (external) opening of the bowel. After the food has been churned up in the stomach for some short time, and well

mixed with digestive juices, the circular band of muscle guarding the beginning of the small bowel relaxes from time to time, allowing portions of the chyme to escape into the intestine, and in the course of three hours or so after an ordinary mixed meal all the food has left the stomach in this way.

As the food passes along the small intestine two more fluids of importance are mixed with it. These are the *bile* and the *pancreatic juice.* Bile comes from the liver—a large solid organ lying chiefly under cover of the lower ribs on the right side, and its chief function is to aid in the digestion and

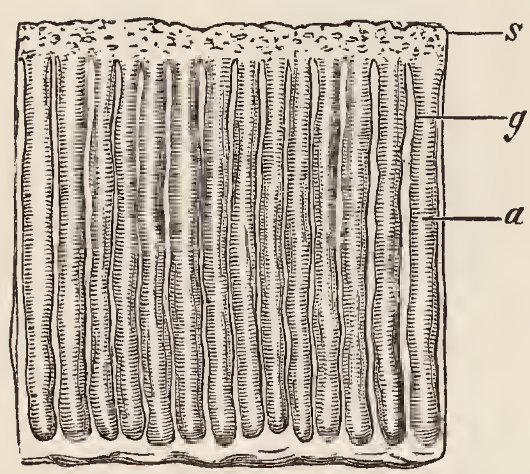


Fig. 30.—The Mucous Membrane of the Stomach in section, highly magnified

s points to the surface, *g* to one of the tubular glands, of which *a* indicates the central canal. A is a much more highly magnified view of one gland, which is represented as giving off branches. It shows the columnar epithelium of the surface dipping down into the duct *d* of the gland, from which two tubes branch off. Each tube is lined with squarish cells, and there is a minute central passage. Here and there are seen other special cells (coloured black in figure) called parietal cells, which are supposed to produce the acid of the gastric juice.

absorption of fat. It is poured into the small intestine at a point not far from its commencement, reaching it by a tube or duct from the liver. At the same point, the juice or secretion from the pancreas, carried by its own duct, enters the intestine (fig. 31). The pancreas or sweetbread is a long finger-shaped gland lying below the stomach, and its secretion or juice is of great importance in digestion. It contains no fewer than four digestive ferments, viz.: (*a*) *Trypsin*, which turns

albuminous or proteid food into soluble peptones; (*b*) *Amylopsin*, which converts starch into sugar; (*c*) *Steapsin*, which partly emulsifies fat and partly changes it chemically; and (*d*) *Rennin* or a similar ferment, which can curdle milk. As the food slowly passes along the bowel it becomes mixed with these fluids, and digestion is in this way completed. It is true that the wall of the small intestine itself furnishes a juice—the *succus entericus*,—but its digestive power is very feeble, and we need not consider it at any greater length.

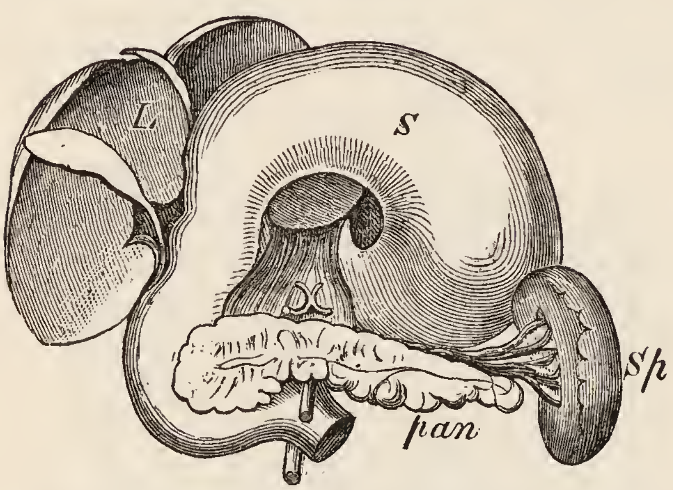


Fig. 31.—Relations of the Stomach (S) to the Liver (L), Pancreas (*pan*), and Spleen (*Sp*)

The food the person has swallowed is now much transformed, the object of all these processes being to render it suitable for passage into the blood stream, whereby it may be carried to all parts of the body for their nourishment. The proteid food has become soluble peptones; the starch and cane-sugar are now in the form of grape-sugar; fat is broken up into very minute globules (emulsified) and in part is chemically altered; while salts or mineral matters are in solution in water, or in some form of liquid food. These various kinds of foods are now absorbed, the fat by little finger-like projections called *villi*, that cover a large part of the mucous lining of the small bowel, and which take up the minute globules of fat and discharge them at length into the blood, while the peptones, sugar, and salts find their way directly into the capillaries lining the wall of the intestine (fig. 32). So the body is nourished.

That part of food which is non-digestible—skin, gristle, stems of vegetable, skins and seeds of fruit, and so on—passes through the large intestine, to be voided externally as the *fæces* or motions. A daily evacuation of this kind is very important,

and children should be taught from their earliest years to be regular in this habit. Inattention to it is responsible for much indifferent health. The teacher, wherever it lies in his or her power, should try to guide the child in this important matter.

Such, then, in brief, is the physiology of digestion. The food absorbed is carried, along with oxygen, to every part of the child's frame. It replaces the particles lost through functional activity, and it adds the material required, over and above this, for actual growth or increase in size. This is the case with the normal child receiving an adequate supply of food of proper kind, and having day and night a due supply of fresh air. But what of his underfed companion? The latter, unfortunately, is only too easily found in the large public elementary schools of our great cities. Thin, pale, meagre, perhaps stunted; poorly clad, for who would spend money on clothes unless the cravings of hunger were first satisfied; affected perhaps with skin-eruption, with sore eyes, or other physical ailment favoured by his ill-nourished condition, and not infrequently verminous and dirty;—this is the picture which such children present to our eyes. Children of this type are, unfortunately, only too common in the poor parts of our large towns, and the problem as to how best to deal with them is one alike pressing and yet difficult of solution. The teacher who has material like this to handle is bound, if he be anything more than a machine, to ask himself the question: What capabilities of instruction do these feeble creatures possess, and how can they perform the ordinary exercises and drill with their feeble bones and muscles? It is clear exemptions must be made in these cases, and the

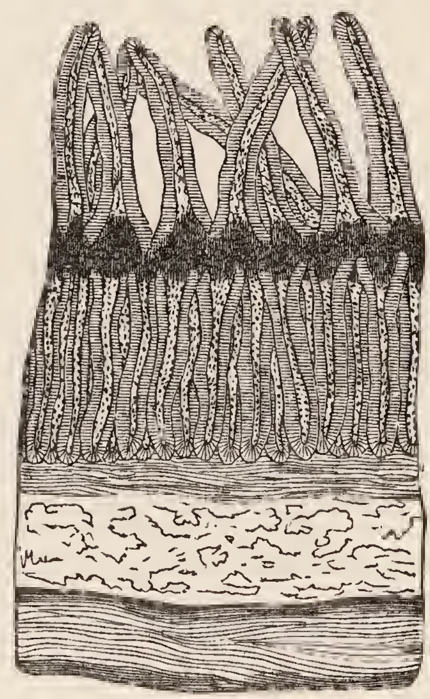


Fig. 32.—Microscopical Structure of the Small Intestine, as seen in cross-section

humane and sensible teacher will rely on his own common sense, backed up by a true knowledge of the laws of health.

Bad Feeding in Early Life.—Not a few children come to school not only suffering from want of food, but bearing permanent traces of the bad feeding which has characterized their very early years. This is evidenced chiefly in the form of *rickets*, a condition of great importance not only on account of the fatal issue too often attendant upon it or its complications in the early years of life, but also on account of the gross and often crippling deformities which may result from it and persist all through life. The foundation of rickets is laid in early life during the time of appearance of the milk teeth, and the key-note to its pathology is bad feeding. No doubt other factors aid its development, such as damp and dark dwellings, defective admission of fresh air and sun-light, and neglect of the skin of the child; but after allowance is made for all these, we come back to the paramount question of food. At the present time, in spite of all that has been done, the ignorance exhibited by mothers of the working-classes (and not of these only), with regard to the proper food for infants and young children, is appalling. In the case of the former we have as a result a high infantile mortality; in the older child we get the onset of the rachitic condition. Year by year we find fewer mothers nursing their children and giving them the nourishment Nature intended them to get, or, if they do feed the child naturally, they leave off much too early, perhaps at the third or fourth month of life. The child is then fed on some proprietary infant-food, cooked perhaps with water. Those foods are largely starchy and saccharine, and certainly fatten the child in many cases, while at the same time they fail to build up sound bones and sturdy muscles. Later on, instead of porridge and sweet milk, broth or soup, vegetables and perhaps a little fish or an egg, the child is fed largely upon tea and bread and jam. Not infrequently it is simply the laziness and incapacity of the mother which keep her from preparing a proper mid-day meal, and the unfortunate child coming home

from playing on the street, or, later on, from school, receives a cup of sweet tea, and bread or pastry, with jam, syrup, or treacle, instead of a proper dinner. The child, it may be added, has no objection to this form of repast. But in the course of these first few years of early life and improper dieting, when the soft and gristly bones of infancy should be replaced by firm, solid osseous tissue capable of supporting a sturdy frame, there has been a great overgrowth of poor defective bone, and as the child grows heavier and moves about, the weight of the body causes serious bending and deformity of the legs. At the lower ends of long bones, where bony growth chiefly occurs, the large portions of overgrown poor bone can readily be felt. They are easily noticed at the knee and wrist of rachitic children. The head is large and square, and the forehead often shows overgrowth of bone, evidencing itself as a sort of boss on each side of the middle line. The ribs, like other bones, are badly formed, and they yield, sinking in at the sides and pushing the breast-bone forward. Every year the writer sees numbers of children in this state at the large elementary schools in poor parts of this city, and the unfortunate thing about it all is that so much of it is preventible. By the time the children come to school the mischief is done. The teacher can do little then for the victim except to spare him some parts of the physical exercises. In not a few instances the deformities produced are so great that the children cannot really mix with other children in ordinary school life, but must be placed in a department specially arranged for crippled or physically defective children. What the teacher can do, especially with her girl pupils, is to try to teach them more of the simple laws of Nature than their parents knew, to train them in plain cooking and in elementary domestic economy, so that when they in turn marry and have children they may tend and feed them so as to make rickets a rare disease.

Suitable Food for Young Children.—The great fault in the kind of food which causes rickets is that it is too rich in sugar and starch, and often is not a fresh but a preserved food-stuff.

The child needs a dietary relatively richer in proteid and fat than the adult, and should get:—

1. Plenty milk daily, some to be taken with porridge.
2. Meat (beef or mutton), or fresh fish, once daily;
3. Or broth, soup, and eggs or rabbit.
4. All kinds of cereal and farinaceous foods.
5. Potatoes or vegetables daily, and often fruit, as prunes, bananas, and oranges.
6. Bread at every meal, with butter or margarine or dripping, and a moderate allowance of syrup or jam.
7. Little tea or coffee; thin cocoa made with milk is very suitable.

In a great number of instances it is not want of means, but want of training and sense, that keeps a mother from providing a proper dinner for her children at school. Where the teacher can, she should try to inculcate on her the benefit of giving children porridge and sweet milk, fresh fish or an egg, soup or broth made from a stock prepared from crushed bones, and plenty of good bread and margarine. The above, except perhaps eggs, are very moderate in cost in our large cities, and a child will find in a large bowl of hot lentil or potato soup, eked out by a big slice of bread, a very comforting and substantial dinner. Enough broken bones for stock can be purchased from the butcher for twopence, a pound of lentils will cost perhaps twopence-halfpenny more, and, allowing one halfpenny for pepper and salt, a supply of good soup, sufficient for the dinner of a medium-sized family for two days, can be prepared for fivepence.

The progress of children in physical development is best gauged by weighing and measuring them and getting the chest-dimensions, while the same data serve to determine how far any child falls behind or exceeds the average for that age. The following table, taken from Holt's *Diseases of Infancy and Childhood* (2nd edit. 1903), may be of interest in this respect. It is based on 8000 observations made by Bowditch in Boston:—

Age.	Sex.	Weight (pounds).	Height (inches).	Chest-girth (inches).
5 years......	Boys	41·2	41·7	21·5
	Girls	39·8	41·8	21·0
6 years......	Boys	45·1	44·1	23·2
	Girls	43·8	43·6	22·8
7 years......	Boys	49·5	46·2	23·7
	Girls	48·0	45·9	23·3
8 years......	Boys	54·5	48·2	24·4
	Girls	52·9	48·0	23·8
9 years......	Boys	60·0	50·1	25·1
	Girls	57·5	49·1	24·5
10 years......	Boys	66·6	52·2	25·8
	Girls	64·1	51·8	24·7
11 years......	Boys	72·4	54·0	26·4
	Girls	70·3	53·8	25·8
12 years......	Boys	79·8	55·8	27·0
	Girls	81·4	57·1	26·8
13 years......	Boys	88·3	58·2	27·7
	Girls	91·2	58·7	28·0
14 years......	Boys	99·3	61·0	28·8
	Girls	100·3	60·3	29·2

These weights include the clothing. The average weight of school clothing at 5 years for both sexes was found to be 2·8 pounds; at 7 years for both sexes, 3·8 pounds; at 10 years, for boys, 5·7, and for girls, 4·5 pounds.[1]

The general experience of the writer, after determination of the weight and height of children in a school in a poor part of Glasgow, is that they do not quite come up to the American figures. Every now and then a big boy or girl is found who well exceeds the figures given above, but the rank and file fall somewhat below them. This is not to be wondered at, as we may be quite certain that any hundred children taken at random from a public school in Boston will be found to be bigger and better nourished than the same number picked haphazard out of a school in the neighbourhood of a poor district in this country. The writer, in 1906, went over and averaged the heights and weights at various ages (both sexes)

[1] All that is needed is a simple lever-balance with upright attached, provided with a movable arm. A few stout linen tape-measures, clearly marked, suffice for chest-measurements.

of 1000 school-children in an elementary school situated between a good artisan district and a very poor locality. The following results were obtained:—

Age.	Sex.	Weight (pounds).	Height (inches).
5 years......	Boys	37·0	38·5
	Girls	38·2	39·5
6 years......	Boys	40·4	41·1
	Girls	40·3	41·1
7 years......	Boys	44·6	43·2
	Girls	45·3	42·8
8 years......	Boys	48·5	45·2
	Girls	51·4	45·5
9 years......	Boys	52·9	46·2
	Girls	53·7	46·6
10 years......	Boys	57·3	48·7
	Girls	55·0	47·8
11 years......	Boys	61·0	50·5
	Girls	59·4	50·1
12 years......	Boys	68·2	52·5
	Girls	66·0	52·2
13 years......	Boys	70·3	53·3
	Girls	71·0	54·5
14 years......	Boys	73·2	55·0
	Girls	80·0	56·5

The weights include the clothing. Two things strike one in the results:—(1) The weight and height of the girls is in many cases as good as that of the boys; in a few instances it is superior. (2) The results are much inferior to those in the American table. The Glasgow boy of 8, in this school at least, weighed but 48·5 pounds; his American brother, 54·5; the girl of 8 in this school measured only 45·5 inches, her sister across the Atlantic was 48. And so with other ages. The difference arises probably from the better feeding and housing of the Boston children, and the greater attention that has been paid to physical exercises for some years past, in the States.

The Provision of Meals for School-children

This is not the place for a discussion on the merits or demerits of a bill to provide meals for necessitous school-children. Everyone must sympathize with the poor, unfortunate, hungry little creatures, ill-clad and shivering, who attend the schools in the poorest parts of large cities, and everyone must feel how inadequately they are fitted either to receive mental instruction or to benefit by physical exercises. This feeling, actuating kind-hearted persons, has led to the establishment of many charitable organizations which seek to remedy this pitiable state of affairs. The Free Meals Bill aims at accomplishing the same end in a more thorough fashion, at the expense and under the direction of the State. It is said that as the State provides education, and insists on children availing themselves of the same, it should also provide the means whereby the really needy can be enabled to make good use of this education. To provide food for these hungry children is a duty which the State owes alike to them, to society, and to itself, since these are its future citizens. On the other hand, it is urged that this would mean a lessening of parental responsibility, and that the partaking of meals out of the home would tend to loosen one of the closest bonds of family life—the common meal. It is stated that intemperance is one of the greatest causes of poverty and misery, and consequently very largely responsible for the underfed child, that one meal a day will not meet the case, that misfeeding is responsible for much ill-health at present attributed to want of food, and that dirt and want of fresh air make the condition of the underfed child worse. Charitable societies, by a little more exertion and perhaps better organization, could, it is said, cover all cases of want, and finally it is pointed out that if meals are to be provided, the educational authorities are not the proper persons to do so. At the conference of the National Union of Teachers held in April, 1906, it was agreed to amend clause 34 (B):—

1. That if any public cost be incurred in connection with

feeding of necessitous children, it should be a charge upon the Imperial Exchequer.

2. That the feeding of school-children should not take place in rooms or halls used for school purposes.

3. That the supervision should not be cast upon the ordinary teachers of the schools.

The Education (Provision of Meals) Bill received the royal assent on December 21, 1906, and was duly placed on the statute-book. It is a permissive act, and empowers Local Education Authorities to assist voluntary efforts for feeding underfed school-children, by providing buildings, furniture, apparatus, &c., the food to be furnished by voluntary effort. Where the Local Education Authority is satisfied that there are children in want of food, and that earnest voluntary help is not forthcoming, they may, with the consent of the Board of Education, provide the food also to the extent of a half-penny rate. Provision is made for requiring payment for the meals from parents able to pay. At the last moment it was decided that this bill should not apply to Scotland, but there is a strong probability that a separate bill for that country will be introduced at an early date on somewhat improved lines.

Whatever our views may be with reference to placing of such an Act upon the statute-book, we all agree in hoping that this sad problem may be successfully solved, and would gladly hail the day when, through the length and breadth of the country, there could be found in our elementary schools no underfed or necessitous child.

CHAPTER VI

The Nervous and Muscular Systems of Children—Their Physiology—Waste and Repair with special reference to Childhood—Bodily Exercise in Relation to Health—Change of Occupation—Fatigue and Rest—Signs of Exhaustion of Nervous System—Sleep.

No one who is much with young children can fail to be struck by the almost ceaseless activity which they display.

Movement is almost synonymous with life to them, and to restrain their bodily activities is to impose a very trying restriction upon them. The consideration of this active life of the young leads us appropriately to a study of the muscular system, by which the movements are performed, and of the nervous system, which presides over and controls the actions of the muscles.

The Nervous System. — This consists of a central portion, the brain and spinal cord (fig. 33), and of a peripheral or outlying part, the nerves and their endings in skin, organs, and muscles. Nervous tissue is soft and whitish, and somewhat oily to the touch. It is made up of nerve-cells and of connecting nerve-fibres. The brain, enclosed in its protective casing, the skull, is the very centre and head of the nervous system; it is composed of many millions of nerve-cells of microscopic size, with a bewildering net-work of interlacing fibres passing between them. It is the seat of all intellectual and psychical processes—of volition, ideation, memory. It gives off nerves of great importance

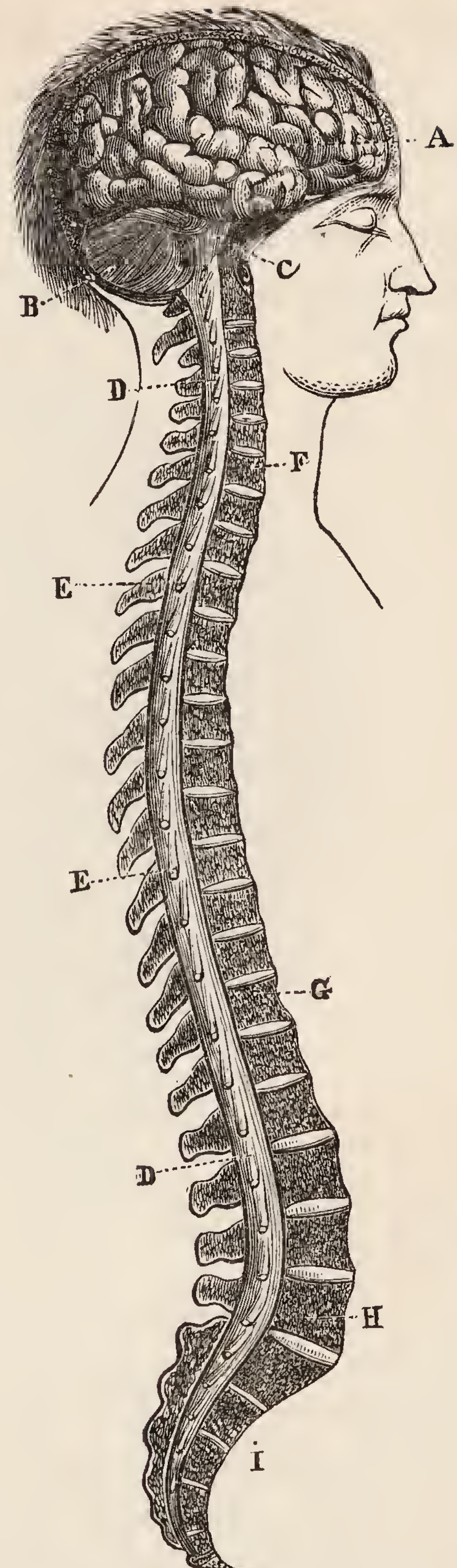


Fig. 33.—Brain and Spinal Cord in Position

A, Cerebrum, or brain proper; B, cerebellum; C, pons Varolii, and below it the medulla oblongata; D, D, spinal marrow, showing the origin of the spinal nerves; E,E, spinous processes of the vertebræ; F, 7th cervical vertebra; G, 12th dorsal vertebra; H, 5th lumbar vertebra; I, sacrum.

passing directly to the eye, the nose, the ear; to the skin and muscles of the face; to the tongue, and to the heart, lungs, and some of the abdominal organs. Through its activity we smell, see, and hear, and by the action of muscles controlled by its nerves directly, we speak and sing, assume various facial expressions, chew and swallow our food, and so on. It is composed of two chief portions, the greater brain or *cerebrum*,

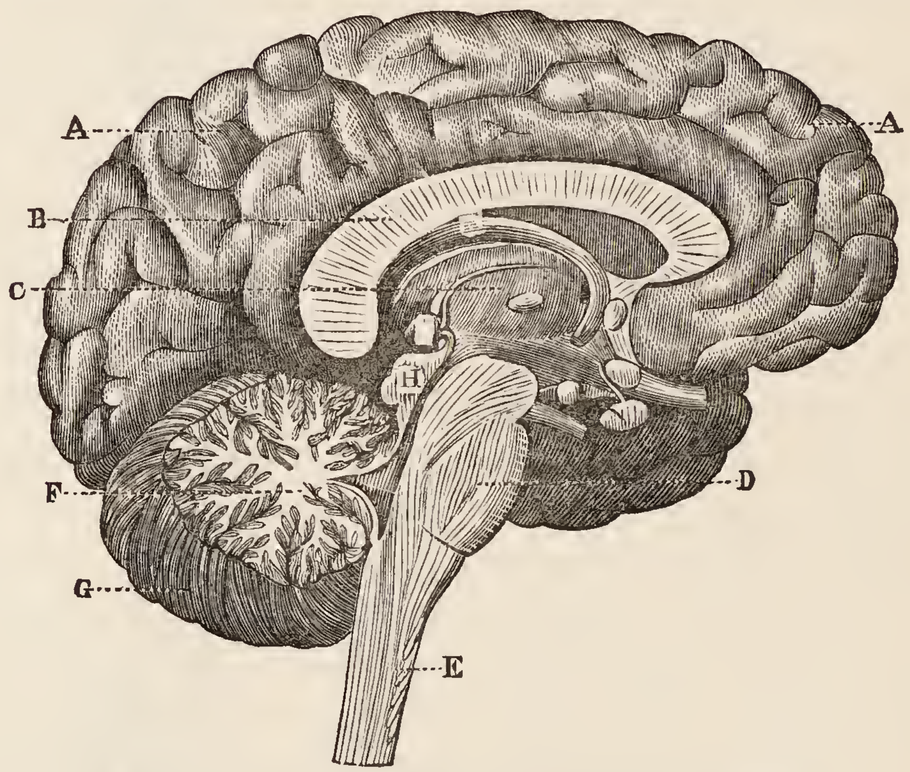


Fig. 34.—Median Longitudinal Section of the Brain

A A, Left cerebral hemisphere; B, corpus callosum; C, 'twixt brain; D E, medulla oblongata; F G, cerebellum, the cut surface of which shows the arbor vitæ; H, optic lobes.

and the lesser brain or *cerebellum* (fig. 34). The former is composed of two segments partially separated by a fissure running from front to back. These halves are termed the *cerebral hemispheres* (fig. 35). The studies of physiologists, have substantiated the fact that certain portions of the brain have special functions; that is to say, the nerve-cells collected in one particular part perform a definite function, either to send out messages to move the muscles of a particular part of the body, or to receive sensations which produce a definite effect on our consciousness. These localized portions of brain-tissue of known activity are termed *centres*. Thus we have

a centre for speech, one for movement of the face-muscles, of the right and left arm and leg, and so on, and also centres for the reception and interpretation of sensations of taste, smell, hearing, sight, and touch.

Although the brain is the sovereign of the nervous system, all messages do not leave or return to it by the nerves which

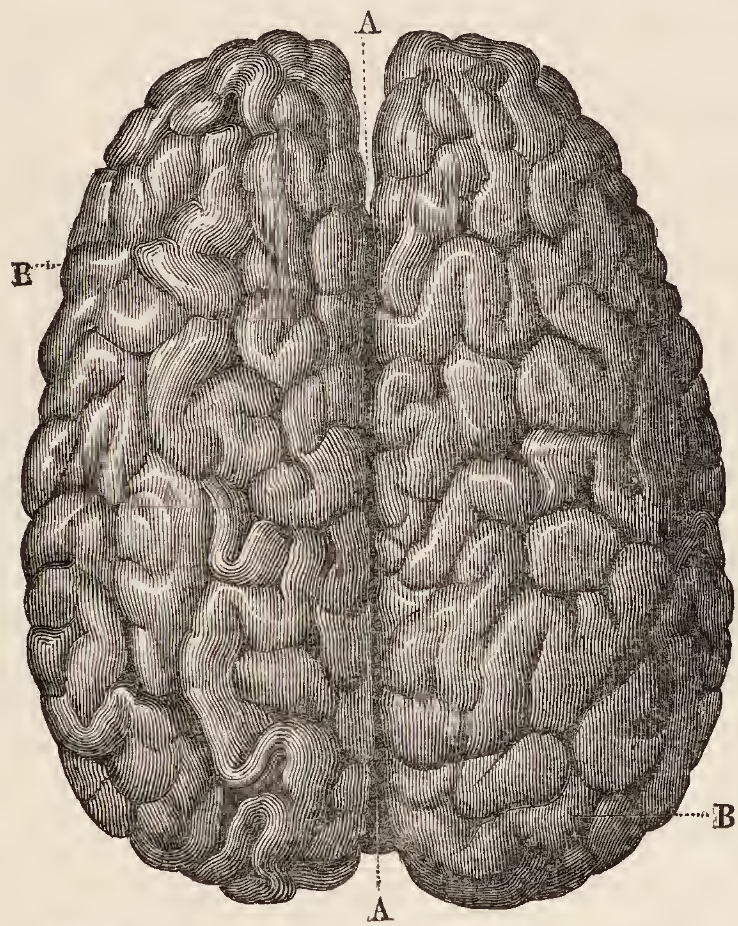


Fig. 35.—View of Upper Surface of the Brain

A A, Great longitudinal fissure; B B, cerebral hemispheres.

spring directly from it. Many of these messages enter the second great part of the central nervous system, the spinal cord, encased and protected by the vertebral column, or backbone, and reaching from the lower part of the brain to the lower part of the vertebral canal (see fig. 33). Symmetrical pairs of nerves spring from it at intervals all the way down its course, to be distributed to the arms, neck, and chest, to muscles of the abdomen, hips, and back, and to the legs. Messages sent out from the brain to these parts must accordingly travel down the cord till they can leave it by the proper

nerve or nerves, while messages going to the brain from these regions must enter the cord first and thence mount up to the cerebral hemispheres. If the cord be seriously damaged in any part, as, for example, when a man's vertebral column is broken, no messages can pass from or to the brain beyond the break, and from that point downwards there is paralysis, since the cord itself can neither feel nor initiate movement. If there is loss of nervous community between any part and the brain, sensation and motion in that part are lost.

The Nerves.—These act the part of telegraph wires conveying messages from central despatching stations. It is clear that the messages transmitted by nerves must either pass out from the centre (*efferent*) or travel inwards towards the centre (*afferent*). Those that pass out go almost entirely to excite movement, and so the nerve-strands and fibres which convey them are termed *motor*; while those that pass inwards convey sensations, and the corresponding nerves are termed *sensory*. Some nerves are entirely sensory, as the nerve to the eye (optic nerve), which conveys nerve impulses to the brain to be translated into vision; while others are wholly motor, as, for example, the nerve which is distributed to the muscles attached to the outer surface of the eyeball, and which move it in different directions. The majority of nerve trunks, however, are mixed. In addition to sensory and motor impulses, nerves also convey impulses which have some effect in keeping up the nutrition or tone of the part to which the nerve is distributed; nerve-fibres of this kind are said to be *trophic*. It will be remembered, too, that in discussing the circulation of the blood it was pointed out that the calibre of the smaller arteries was under control of the nervous system. The nerves that take part in this are termed *vaso-motor*, and may either diminish the size of the vessel (*vaso-constrictor*) or increase it (*vaso-dilator*).

The Muscular System.—Muscles are what we popularly term the lean or flesh of meat. They are either *voluntary*, that is under direct control of the will, such as the muscles of the arms and legs, or *involuntary*, moving in response to messages sent out automatically by the nervous system, but beyond our

volition; such are the muscles of the wall of the stomach and bowel. It is with voluntary muscles that we are specially concerned here (fig. 36). They are of various shapes, most frequently being long and cigar-shaped, or like a very long triangle; in other instances they more resemble a broad triangle, or are roughly quadrilateral. They consist in the main of thick, fleshy fibres, forming the *belly* of the muscle, and at each end of a long muscle, or at two opposite sides, it may be, of a square one, the fibres are gathered together and end in a firm, whitish structure termed the *tendon* of the muscle. By these tendons muscles are attached to bones, one tendon being fastened to one bone, the other to another, with a joint intervening. Sometimes a muscle will pass over two joints in its course. When a muscle contracts in response to a motor stimulus sent out from the brain, it shortens, each fibre diminishing in length, while it increases in cross-section. This shortening brings the ends of the muscle (or its tendons) closer together, thus drawing the bones nearer to which the tendons are fastened, and so bending the intervening joint (fig. 37). Each muscle has its own work to do, its own action to perform, though this does not necessarily differ much from that of its neighbour. In many movements, three, four, or more muscles may be employed conjointly.

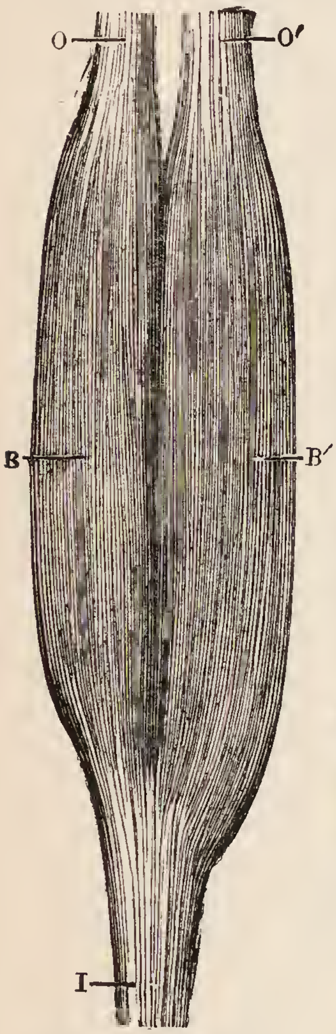


Fig. 36.—Biceps Muscle of the Arm

B B′, Belly;
O O′, origin;
I, insertion.

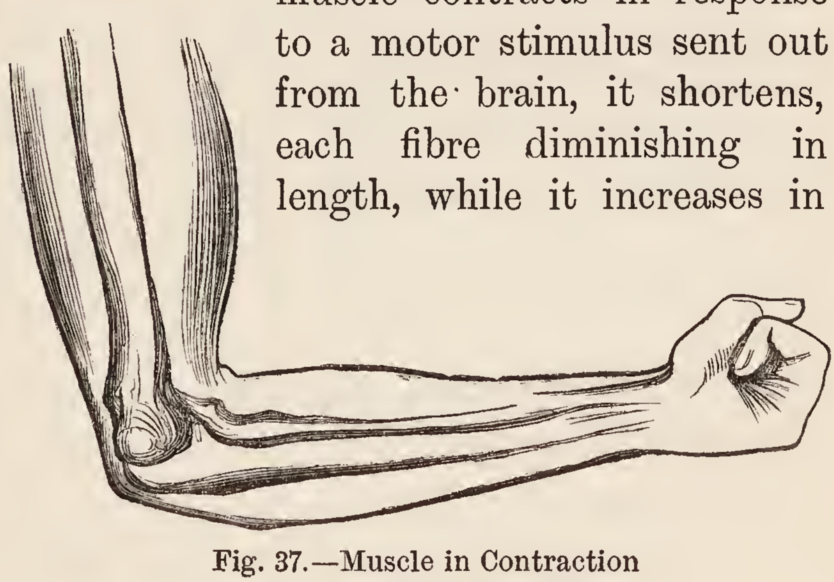


Fig. 37.—Muscle in Contraction

There are certain points which all interested in the training of children should keep in mind. One is, that the brain is not so fully differentiated and mapped out, nor so specialized in function in the child as in the adult. It is not an identical brain, merely smaller in size, which the child possesses. It is a less elaborate organ, with certain nerve-cells and nerve-paths still in process of development, still undergoing evolution. Another point of importance is, that the nervous system of the child is very sensitive to harmful outside influences. Foul air, dark and unwholesome surroundings, a heated atmosphere, all affect children to a greater degree than they do adults, and one of the parts of the body most easily adversely affected in this way is the nervous system. The muscular system of the child is capable of great training and development. Given good air and good food, the increase in bulk and quality of muscle that can be produced by using it, is very striking. Since muscles are attached, as a general rule, by their tendons to bones, the latter increase *pari passû* with the growing muscle, to afford a wider base for tendinous attachment, and as the bones increase in size we have a similar effect produced on the joint formed by the apposed ends of the bones in question. This gives greater stability and greater ease of movement to the body. For these results to be attained, however, food in proper amount is absolutely necessary. If growth is active in children, so is waste, and, as mentioned in a previous chapter, all the chemical bodily processes—the general metabolism—of the child are more active than in the adult.

Physical Exercises in School Life

While it is proposed to give fuller consideration later on to special exercises, it is advisable at this point to discuss the subject of physical exercise in its general bearing on child-nutrition. While the teacher is engaged in "bringing on" the pupil, he must not lose sight of the training of the body. It may be said at once that the brain and the muscular system are so interdependent that one cannot have the brain at its

highest point of vigour without a properly-developed muscular system. No doubt there have been, and are, exceptional cases where with a feeble or deformed bodily presence there has been a great and luminous mind. But, taking the vast average of children in a public school, it may be said truthfully that brain and body must be trained and educated side by side. While each muscle or group of muscles has its own brain-centre, and acts in response to messages proceeding therefrom, each nervous centre needs external stimuli to develop its potential power. The development of parts of the brain is really dependent on muscular movements, and this probably explains the spontaneous and almost continuous restlessness of young children, kittens, puppies, lambs, and other young animals.

Exercises should, at least in part, have the attention of the pupil given to them, in order that the higher brain-centres, being called into action, may be developed. They should not be done mechanically (reflex action), or much of their beneficial effect is lost. The exercises should be graded, and special exemption should be made in the case of the physically defective, though it is a great mistake to think that the latter should have no exercise at all. They need, for its general effects, a regular term of daily exercise as much as their abler-bodied brothers and sisters do, but it must be adapted to their physique.

Speaking generally, the good effects of physical exercise are as follows:—

1. It comes as a welcome addition to brain-work, relieving the intellectual centres to a large extent, and exercising the motor. The cerebral circulation is improved, congestion of the head averted, and better school-work is obtained.

2. It quickens and improves the general circulation, and leads to increased power and activity in the heart muscle. This is because the muscles generally, being brought into active play, demand a greater blood-supply, and the heart responds.

3. As the circulation is quickened, so is the respiration. The working muscles need plenty oxygen, and respiratory movements must be quicker and deeper to supply the increased demand. There is a corresponding increase in the output of carbonic acid.

4. The lungs, exercised in this way, increase symmetrically in volume, and with them the cage or chest in which they lie, and which is so plastic in the child. This increased respiratory capacity is associated with a greater power of resistance, especially to lung complaints, while the child with the poor, flat chest is very susceptible to pulmonary ailments.

5. It restores wasted and ill-developed muscles, bringing them up to the normal. Muscle has a wonderful power of meeting demands made upon it, and of increasing in bulk and quality (*hypertrophy*, in its good sense), provided an adequate supply of food is given too. Muscles unused, even though food be given, waste or atrophy, becoming thin and flabby.

6. It greatly affects the growth of bones and joints in childhood, because, as we have seen, muscles are attached to bones, and as they increase so do the latter. The leg- and arm-bones of the child are long, slender, and largely composed of gristle. They are greatly affected by muscular action, and if this be wanting they remain slender and weak, tending to bend and to cause deformity.

7. From what has just been said, it will be seen that regular and regulated exercise affects all the bones and produces a harmonious and equal development.

8. As a result of its effect on all the systems of the body, it improves appetite, induces better sleep, and promotes the whole "tone" or well-being of the body. It conduces also to a healthy action of the skin, the kidneys, and the bowels, those structures which carry off the waste and harmful products of the body's activities.

9. From their effect on bones and joints, exercises can do much to correct deformity, especially in its incipient stages. They expand the chest-wall, make each side grow symmetrically, do away with spinal curvature and the prominent shoulder-blade so often seen with it, and help the child with flat-foot to regain an arch for the foot.

10. Exercise leads to a graceful walk and attitude, abolishes slouching and shambling walking, and gives spontaneity and freedom to all bodily movements.

11. It has a mental effect in the way of educating groups of muscles to act together so as to produce co-ordinated effect, and it leads to improvement in memory.

12. Lastly, physical exercise confers moral benefits on the child by promoting such qualities as promptitude, obedience, willingness, and determination. These combined physical, educational, and moral effects lead to an improvement in the child's whole nature. In conclusion, it may be stated that at intervals, in all systematic exercises there should be a break for two or three minutes to allow of a march, a general run, or some spontaneous play.

Fatigue and Rest.—After exercise of either brain or muscles comes fatigue—a feeling of weariness, of inability to do more, and a cry on the part of the organism for a period of rest. Fatigue of muscle has been more thoroughly studied than that of the nervous system, since exhaustion of the latter can, in many cases, only be manifested through the muscles.

Muscle in excessive use is tired out, partly through consumption of energy-producing material within it, but still more through the accumulation of poisonous or toxic bodies, the result of its own chemical activity. One of these toxins is an acid named *sarcolactic acid.* This part of the subject has been carefully studied by Mosso and Waller, the former making use of a piece of apparatus called the *Ergograph* (lit. work-recorder), whereby the activity of individual muscles can be studied under varying conditions, *e.g.* after a meal, or when fasting, by night or by day, and so on. In the course of his investigations Mosso discovered a very curious thing, viz., that if the blood of a fatigued animal were injected into the system of a normal animal, the latter showed signs of weariness, as if it too had been severely exercised. This supports very strongly the hypothesis that toxins in the blood poison the muscles and produce the feeling of tiredness. In physiological experiments where perhaps a single muscle is studied, it has been found that the part poisoned is the ending of the motor nerve in the muscle, but in the intact body another factor comes into play, viz., the poisoning of the central

nervous system by absorbed products. A proof that exhaustion occurs in the motor-centres of the brain, and not in the nerve-trunks, is found in the following experiment of Mosso's:—

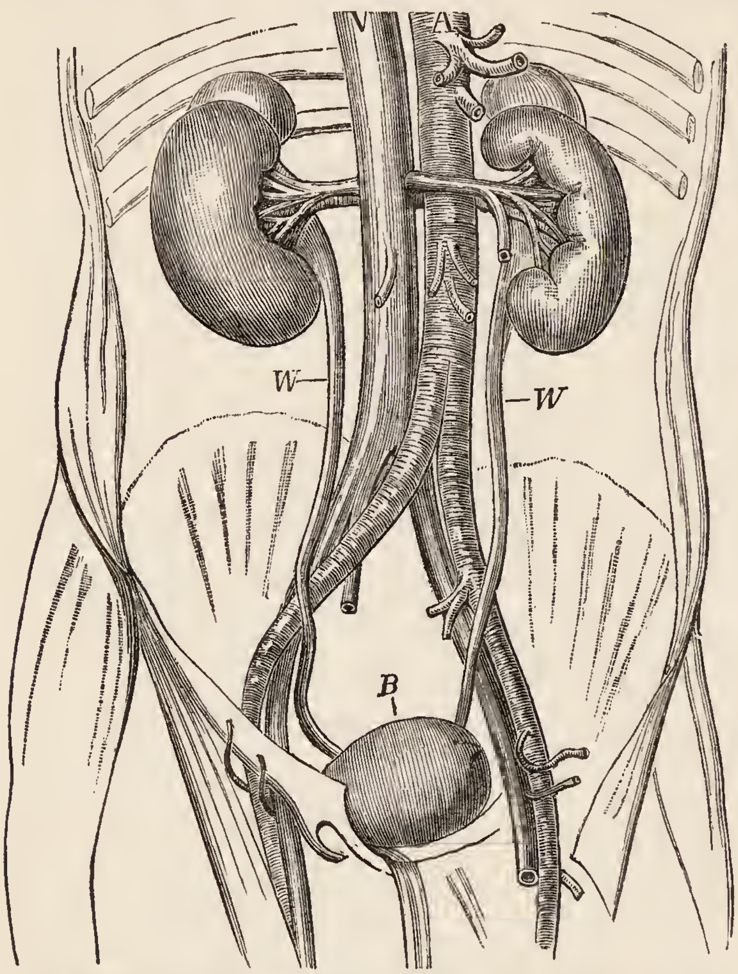


Fig. 38.—Showing the Kidneys and the Structures in connection with them

W, W, Ureters; B, urinary bladder. In the centre of the figure (to right) is seen the dorsal aorta (A), giving off the renal arteries and forking below into iliac arteries. The inferior vena cava (V) is also seen, made up by union of the iliac veins below and receiving renal veins from kidneys.

The hand and all fingers save one were fixed in the frame of the ergograph. To the free finger was fixed a cord passing over a little pulley and attached to a weight. The person was asked to flex and extend the finger as often as possible, thus raising and lowering a known weight through a definite distance. When at length the finger seemed so exhausted that the will could no longer make it move, stimulation by the induced current of the nerve-trunk leading to the muscle still caused contraction, showing that it was the brain-centre, rather than the nerve-trunk or the muscle itself, which was exhausted.

Rest.—Rest in the case of both nervous and muscular system permits of the sweeping out of waste and effete material, and so of recuperation. A large proportion of the waste and toxic materials are removed from the blood by the action of the kidneys, two organs placed in the abdomen somewhat high up, and near the backbone (fig. 38). The secretion

of the kidneys consists of water, organic waste material, and salts, and is known as the *urine*. It finds its way continuously by a tube (the *ureter*) from each kidney to the bladder, whence, at intervals, it is discharged from the body. No health can be maintained without normal functional activity of the kidneys, as none of the other eliminators of body-waste (lungs, bowels, skin) can adequately take their place. In addition to this process of clearing out of waste harmful products, there is, during rest, an addition to nerve and muscle of fresh energy-producing molecules, capable of yielding fresh power of work during the hours of activity. To try to work without rest is precisely on a par with an attempt to get steam from a boiler continuously without either clearing away the ashes from the furnace floor or adding fresh fuel and water.

Taking attention as a test of freshness of nerve-power, Chadwick long ago pointed out for how short a time attention could be fixed in young children, and that the period increased with years:—

At 6 years	attention can be	fixed for	15	minutes.
At 7–10 years	,,	,,	20	,,
At 10–12 years	,,	,,	25	,,
At 12–16 years	,,	,,	30	,,

It is agreed by all authorities that the best work is got out of a school when the periods of mental exertion are short and are followed by physical exercises in the class-room, hall, or playground.

Key's Table for a child's day at different ages is:—

Age.	Sleep.	Dressing, &c.	Meals and Rest.	Free Time.	School Lessons.	Play.
Under 4 yrs.	11 hrs.	1 hr.	3 hrs.	3½ hrs.	2¾ hrs.	2¾ hrs.
,, 4–5 ,,	11 ,,	1 ,,	3 ,,	3½ ,,	2¾ ,,	2¾ ,,
,, 5–6 ,,	11 ,,	1 ,,	3 ,,	3½ ,,	3 ,,	2½ ,,
,, 6–7 ,,	11 ,,	1 ,,	3 ,,	3½ ,,	3 ,,	2½ ,,
,, 7–8 ,,	11 ,,	1 ,,	3 ,,	3½ ,,	3½ ,,	2 ,,
,, 8–9 ,,	11 ,,	1 ,,	3 ,,	3½ ,,	3½ ,,	2 ,,
,, 9–10 ,,	10½ ,,	1 ,,	3 ,,	3½ ,,	4 ,,	2 ,,
,, 10–11 ,,	10½ ,,	1 ,,	3 ,,	3½ ,,	4 ,,	2 ,,
,, 11–12 ,,	10 ,,	1 ,,	3 ,,	3 ,,	5 ,,	2 ,,

Dr. Kremsin, headmaster of a large German school, stated (*Deutsche medizinische Wochenscrift*, Jan. 20, 1898), that the best work was done on Monday and Tuesday, and advocated the mid-week holiday as a means of raising the standard of work of the second half of the week. He found that gymnastics (tested not by muscular but by mental effect) had the highest fatigue-value; next came mathematics, foreign languages, and religious instruction. The easiest to stand were history, home-language, and natural history.

It has been said that the afternoon hours in board schools yield poorer results than the forenoon. Thorndike has adduced arguments against this view, and based them on the following tests:—

1. Multiplication sums to be done in a given time.
2. Mis-spelled words to be corrected in a given time.
3. Nonsense syllables to be written from memory.
4. Figures to be written from memory.

These tests he tried on 590 children, giving one set Nos. 1 and 3 early in the day, and Nos. 2 and 4 in the afternoon, whilst another set got the converse. He could not find any evidence of mental fag in the latter part of the day. Perhaps these good results were due to the way the hours were divided up for school-work, and to the periods of rest. Change of occupation, by bringing other nerve-centres and muscles into play, is in itself a rest. What is often attributed to overpressure is really attributable to breaches of the laws of health. What Board children suffer from most are want of sleep, want of fresh air, and insufficiency of good food. The better work not infrequently seen in the earlier part of the day may be due to fresher air in the class-rooms.

Signs of Fatigue.—A really careful and attentive teacher will be alive to the signs of incipient exhaustion, and will take care not to press the pupil when it is clear that no more good work can be got out of him for the time being. The most important signs of fatigue are:—

1. The attitude of the head (drooping forwards or sideways).

2. Lolling attitude of the body generally, due largely to fatigue of spinal muscles.

3. Failure of attention—a wandering mind and a roving eye.

4. Yawning.

5. Sleeping in class.

Warner has drawn attention to a special listless attitude of the hand as an early indication of fatigue.

Sleep.—Change of occupation, physical exercises, and play relieve a certain amount of the fatigue felt in school, but the best of all recuperative agents is sleep. Its onset is favoured by the person being tired, and also by physical repose, coupled with the exclusion of outside sensory stimuli—noises, light, &c. Young children, in their stage of active growth, require much sleep, and the writer is convinced that a great deal of the listlessness, dulness, inattention, and indifferent bodily health met with in public elementary schools is due to deficient sleep. Anyone who goes much among the working-classes is struck by the late hours kept by children. It is no uncommon thing to find children of seven years of age and less, out of bed till after 10 p.m., and it must be remembered that they are often disturbed early, and made to rise at such an hour as 7 a.m. When they do go to bed it is often in the kitchen, where the father perhaps smokes, or the mother sews, or neighbours drop in for friendly gossip, so that there is both light and sound. These, let it be borne in mind, are quite favourable conditions among the working-class. Much worse conditions as regards rest for the children are found where one or other of the parents drinks, and where there may be no quiet or peace till after midnight, or where a parent perhaps is ill, and even young children must bear a hand in house-work and in nursing. What wonder that at school next day the unfortunate children are dull and weary, heavy-eyed and pale, inattentive and, to the casual observer, very stupid. When questioned as to lack of attention or interest, the child may say nothing, or may whisper "Mother's ill", or "Father was late last night", and the words may seem little, but may cover

a great deal of discomfort, worry, and even suffering in a young life. While exercising due firmness with regard to indolence and laziness, the really good teacher will try to discriminate between the child who *won't* work and the child who *can't*, and will make due allowance for the latter.

CHAPTER VII

The Function of the Skin—Importance of Cleanliness—Clothing—Care of the Hair and Teeth—Juvenile Smoking—The Teaching of the Laws of Health to Children—Teaching of Temperance in Schools.

The Skin.—The skin forms a protective covering to the whole body, and fulfils in addition many other functions. It is composed of two layers—the *epidermis* or cuticle, and the *dermis* or *cutis vera*, or true skin (fig. 39). The epidermis is composed of many layers of flattened somewhat horny cells, and is constantly being shed, to be replaced by new cells growing up from below. The dermis or true skin is fibrous in character and contains many capillaries. It is it that is exposed and bleeds when one "barks" one's knuckles, to use a familiar expression. It is in the true skin that the terminal points of sensory nerves are found.

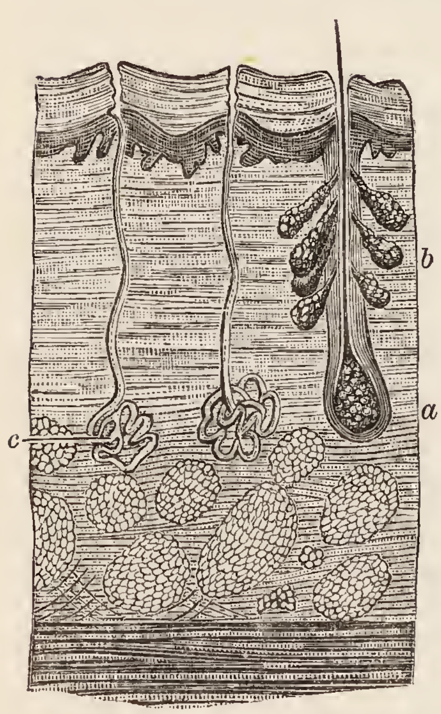
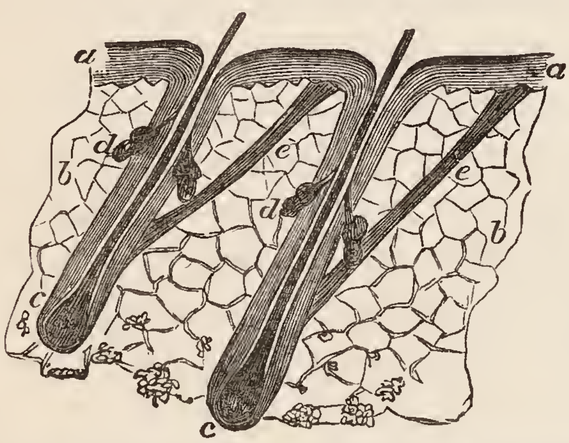


Fig. 39.—The Structure of the Skin. *a*, Hair-follicle; *b*, Sebaceous Gland; *c*, Sweat-gland.

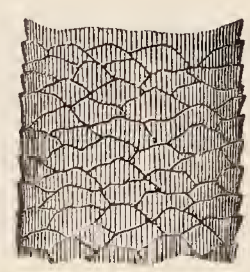
Glands of the Skin.—Two sets of glands are met with in the skin: (*a*) the *sebaceous* (Lat. *sebum*, oil), and (*b*) the sweat or *sudoriparous* glands (Lat. *sudor*, sweat).

The sebaceous glands secrete an oily fluid which is generally discharged into a hair-follicle—the little pit in the skin in which the root of a growing hair lies (fig. 40). The function of these glands is to provide a lubricant, especially for the

hairs. The sweat-glands, on the other hand, after pursuing a tortuous course through the skin, open on its surface directly, pouring out the fluid which we call perspiration or sweat. Whereas sebaceous glands are met with mainly in connection with hairs, sweat-glands occur most abundantly where hairs are very scanty, as, for example, on the palms of the hands and soles of the feet. The sweat is mainly a watery fluid, there being only about 1·2 per cent of solid matter in it, of which the greater part consists of salts, and it contains only a trace of fat. It is constantly being poured out in a quiet



Hair, Hair Follicles, and Glands. *a*, Epidermis; *b*, true skin; *c*, hair bulb; *d*, sebaceous glands; *e*, muscle attached to hair sac.



Hair under the Microscope, showing the cells overlapping like tiles.

Fig. 40

and unobtrusive fashion by the myriads of sweat-glands, and this is termed *insensible* perspiration, as we are hardly aware of its presence. If, however, we are exposed to a high temperature, or exert ourselves vigorously, sweat is poured out in such abundance that the skin may be bathed in it; this is termed *sensible* perspiration, and is also induced by emotion such as fear, and by certain medicines. The secretion of sweat is largely under the control of vaso-motor nerves, which we discussed under the Circulation of the Blood, and persons who flush readily generally perspire easily too. This is well seen in the case of children.

Functions of the Skin.—The functions of the skin are varied and important, and are stated by Halliburton to be as follows:—

1. **Protective.**—The skin, covering the whole of the body, protects it from various adverse influences, especially by means of its horny epidermic layer. It is also protective in another and more important way. Containing as it does the terminations of the nerves of touch, it forms a great tactile sensory organ, transmitting messages of warning instantly to the brain when required to do so. A girl, for example, in a laundry class allows her hand accidentally to touch a very hot iron. A message, a painful sensation, is instantly flashed from the skin sensory nerves to the brain, which as rapidly transmits a message back, *via* the motor-nerves, causing the muscles of the arm and hand to contract and so remove the limb from the dangerous spot. Were it not for this, the skin might be badly burned. That this is quite possible is borne out by the fact that persons suffering from paralysis of the legs, and in whom sensation was wanting, have been repeatedly burned by very hot water-bottles placed close to the skin by well-meaning but ill-advised attendants. The skin nerves could send no warning to the brain, and so the person suffered.

2. **Heat-regulating.**—The body in health is kept at a very steady temperature (about 98·5° Fahr.) by means of a heat-regulating mechanism connected with the nervous system. In the body there is much production of heat through chemical activity, and we would become too hot were it not that this increased heat-production leads to a free secretion of sweat. The body is covered with a thin layer of liquid; this evaporates in the air, and in doing so renders heat latent, and this heat is taken from the body itself, with the result that it is once more cooled down to its proper temperature.

3. **Respiratory.**—The skin of man, and of thick-skinned animals generally, possesses little respiratory power. In man, the skin does give off a little carbonic acid gas, but only $\frac{1}{150}$th of that which is discharged from the lungs. In a thin-skinned animal like the frog, a great deal of carbonic acid can be eliminated through the skin. There is another waste product which the skin gives off in traces, that is, *urea*, the chief solid constituent of urine, the secretion of the kidneys.

4. **Absorptive.**—The skin has a slight power of absorbing substances rubbed into it, especially if they are incorporated with a fatty basis. This is made use of practically in medicine sometimes, in the application of ointments.

5. **Lubricant.**—The skin, through its sebaceous glands, keeps the hairs oiled, flexible, and healthy.

Care of the Skin.—These being the functions of the skin, it is quite clear that unless the latter is kept in a state of cleanliness, the due performance of these functions cannot be carried on. The secretory glands become blocked up, the delicate sensibility of the normal skin is lost, the regulation of heat is interfered with. The child with a dirty skin may become tolerant of its own uncleanness, but it can never be in a healthy condition. The hands and face being most exposed, get most frequently soiled, and require most frequent attention. No teacher should allow a boy or girl with dirty hands or face to remain in class. There is ample provision for such washing in all elementary schools, and it mus be seen by the teacher that it is taken advantage of. The latter cannot follow the pupil to his own home, but by inculcating the virtues of cleanliness at school there is a chance that the teaching may bear fruit in the shape of clean face and hands in the domestic circle.

The whole skin in every person, and specially in the young, requires a proper wash, with warm water and soap, once every week. Under the conditions of life of many poor children it is next to impossible for any boy or girl of, say, ten years to have the luxury of a complete bath at home. This must be provided by public baths or by school baths. The way in which this can be done at school has been discussed under school-baths in Chapter IV, and there is no doubt that the use of cleansing baths at school not only subserves a useful physiological purpose, but inculcates at the same time a valuable moral lesson on the virtues of cleanliness. Children with dirty skins, besides being both unsightly and disagreeable in the school-room, are much more prone to catch cold, and are liable both to irritating non-infectious skin troubles and to

skin parasites (animal or vegetable) which may be transmitted to others. This last matter will be dealt with when treating of the ailments of school life. A very useful way of dealing generally with the problem of dirty children is for the educational authority to appoint nurses to visit and inspect unclean children in schools, and to see that they are properly attended to. Dr. Kerr, of the London County Council, writing on this point last year, says: "The nurses working under the late School Board, and continued by the Council, give no treatment, but are accomplishing a highly important work of considerable educational value. They were appointed first to examine cases of ringworm, and were, in fact, termed ringworm nurses; then their duties were extended to all forms of obvious uncleanness and disease. They also follow up their school work in many cases by home visits, and there is a noticeable tendency, both among the teachers and school attendance superintendents, to utilize the nurses' visits as a means of securing better school attendance."

Clothing.—The exigencies of climate as well as the demands of propriety require that we be clad, and every teacher should be conversant with the leading facts regarding the hygiene of our garments. With reference to very poor children, they must wear what can be got for them and be thankful for it; in the case of children from a good working-class home, it may be possible for the teacher occasionally to give some useful hints regarding the choice of clothes. We get material for our clothes from both the animal and vegetable kingdoms, the former furnishing us with silk and wool, skin, furs, and leather, while the latter gives cotton, linen, straw, and india-rubber. The function of clothing is partly to protect the body, but still more to conserve the bodily heat, a very necessary matter in this climate. As far as school life goes, we need only discuss in any detail certain of the clothing materials mentioned, namely those employed to keep the body warm. Leather is used for boots or shoes, but not for jackets or vests among children here, though no doubt their little brothers and sisters in Russia and Canada use it largely. Straw is merely employed

for hats, and fur is a luxury entirely beyond our youngsters in board schools, if we exclude the cheap fur trimmings on girls' dresses. Silk also is too expensive a material for children of the working-class. The ideal material in our climate for wearing next the skin is one that is a bad conductor of heat (thus conserving the body-heat) and at the same time a good absorbent of moisture, giving it off slowly and thus causing little chilling.

Wool is, for the reasons just stated, a very excellent material for underwear, keeping heat in and taking up moisture quietly and slowly. It is a modified form of hair, obtained from sheep, camels, and goats. Mohair, the basis of plushes and velvets, is obtained from the Angora goat, while alpaca is got from the Peruvian sheep. The Tibet goat gives the beautiful wool known as Cashmere, and camel's-hair is met with in the Jaeger underclothing. Ordinary wool goes to form flannel, cloth, worsted and knitted goods. As it gives off moisture slowly it never chills the surface of the body through rapid evaporation. We would be badly off in the British Isles without wool as a material for our clothing. Unfortunately it has a great tendency to shrink and harden when washed, and it proves very irritating to some skins.

Cotton is obtained from various plants belonging to the family *Gossypium*, and consists of hairs of a downy nature attached to their seeds. It is cleaned and woven into flax, and yields us sheeting, calico, jean, fustian, velveteen, and flannelette. Merino is a mixture of wool and cotton. Cotton is cheap, and lasts well, and does not shrink when washed, but it absorbs moisture badly, and quickly conducts heat away from the body—two qualities very undesirable in a clothing material. It is used very largely in school clothing for underwear, and for blouses for boys and dresses for girls.

Linen is composed of flax, the fibre of the stalk of a species of Linum. It is more expensive than cotton, but much tougher, and is used for making cambric, lawn, and the like. Linen is a good conductor of heat from the body and a bad absorber of moisture, and is worse even than cotton for wear

next the skin. It is capable of taking on a fine lustre, especially if starched, and is therefore largely used for the more decorative parts of dress, such as collars and cuffs.

Silk requires but a word, being too expensive a material for school clothing. It is of animal origin, being a long fine thread spun by the larvæ of certain moths (*Bombyx*). It furnishes us with the dress material called silk, and with satin, velvet, and other fine goods. Silk is a non-conductor of electricity, and can absorb moisture readily from the body. It is now used a good deal for underclothing in the better classes of society.

It is clear from what has been said, that wool being a poor heat-conductor must be one of the warmest of clothing materials (another being fur), while cotton and linen are cool, and suitable for the hot months of the year. The colour of the material also affects the warmth of the material. If the latter be white or of a light colour, much of the sun's heat which falls on it is reflected, and so the body kept cool. If the colour be dark, or the fabric black, much heat is absorbed, and so clothing of this hue proves warmer than the same fabric in a lighter tint. Even where suitable material for children's clothing is available, the garments are often most unsuitable, being unnecessarily heavy, too tight at various points, and in the way where free movements are to be performed. It is bad for all, but particularly for the developing child, to have heavy cumbrous garments with tight sleeves, waist-bands, or garters. These latter impede blood-circulation and respiratory movements, and favour the occurrence of chilblains, varicose veins, and other ailments. Garters should be discarded, and elastic suspenders used instead, while a large part of the clothing should be hung from the shoulders. No constricting bands should be allowed about the neck.

Drs. Notter and Firth, in their *Hygiene* (1905), make the following remarks: "It is probably in the attire of children attending school that the greatest need of a neat hygienic dress is manifest. For girls we would suggest that each should wear a flannel chemise, blue serge knickerbockers fitted to the waist with an elastic band, and no stays of any

kind. Next we would suggest a woollen jersey, and an overdress with shoulder-straps, fitted into the waist with a loose belt. In summer the jersey might be left off and a cotton blouse substituted. For out-of-doors, probably a flannel hood would be the best head-covering in winter, while in summer a head-covering is hardly needed in our climate. Such a dress as this should be not only neat and healthy, but by its smartness would raise the moral tone, and help to give the self-respect that is so often lacking in children."

It is very important that children should have the legs and feet kept warm and dry. Stockings of wool or merino should be worn, and boots should be stout and well-fitting, with a wide sole and a broad low heel. Dampness and chilling of the feet in children are very apt to cause colic, diarrhœa, and other affections of the bowels, besides being a common cause of sore throats and ordinary colds. Many poor children are hardly able to get boots and stockings, and one rejoices to see that not infrequently in severe winters kind-hearted and generous lovers of children raise funds for the provision of these very necessary garments for the ill-clad and necessitous.

The Hair.—It must be insisted on that children at school have the hair kept in a cleanly and orderly state. For boys it should always be kept short. In the case of girls it should be plaited or tied back with ribbon.

Nothing suggests more strongly a want of discipline and care than to see children with untidy heads and dirty faces. The hair requires very thorough brushing each morning, in order to remove scales of skin, fragments of hair, and accumulations of sebaceous matter which, if left, may make the scalp irritable. The head, like the rest of the body, may be the seat of skin eruptions, and it is, on account of its close texture, a favourite haunt of certain vegetable parasites (favus and ringworm), and certain animal pests (the louse, and occasionally the flea). These affections will be considered in detail a little later, but their incidence may be largely prevented by good daily brushing of the hair, regular washing of the same with hot water and soap at appropriate intervals,

and by forbidding the interchange of hats among the children. Indeed it may be questioned whether it would not be better for school-children to do without headgear altogether. For boys the head might be washed at home once a fortnight, in the case of girls once in three weeks. Special means of dealing with ringworm of the head will be discussed under ailments of children. Dr. Kerr, in writing of the experience of London in the matter of unclean heads, says: "The number of unclean heads is continually diminishing. The methods of dealing with these cases are cumbersome and slow, and though the results are excellent, powers for a more rapid method of dealing with objectionable cases are required. These powers should be on the lines of the Glasgow Police Act, so that if a child is found by a duly-appointed officer of the Council (medical officer or nurse) to be in school in an objectionable state, notice may be served on the parents to cleanse the child within twenty-four hours, or it may be cleansed at the public expense and the cost recovered from them."

The Teeth.—In the course of our adolescence Nature provides us with two sets of teeth. The first of these, or *milk teeth*, so named because they appear while the child is still largely on milk, make their appearance first about the seventh month of life, and are usually all present at the end of the second year or very shortly afterwards. They number twenty-four, each jaw having twelve. The only interest they possess, as far as school life is concerned, lies in the fact that they come out during this period, being displaced by the second or *permanent* teeth. The latter appear first at the sixth year, as a rule, and are nearly all present by the end of board-school life, since after the age of fourteen there are frequently only the wisdom teeth to come through. The permanent teeth number thirty-two, or eight in each half of each jaw (fig. 41).

Appearing as they do during school life, the second teeth, in their extrusion from the gums, push out and render loose the milk teeth, and these when just ready to drop out are sometimes a source of annoyance to children, and a cause of wandering attention. The teacher may then with great advantage

twist out the loose tooth, an operation very simple and painless as these teeth have practically no roots, and one which can be easily done with the aid of a small pair of tweezers.

Among children of the working-classes there is a great amount of tooth-decay, half the teeth often being in a very bad state. I attribute this to the influence of four factors—an inherently poor physique, indulgence in hot sweet tea, the consumption of large quantities of inferior sweets, and lastly to the want of brushing the teeth. The teacher can do much to encourage the daily use of a tooth-brush when giving simple lessons on personal hygiene to those under her care. Brushing

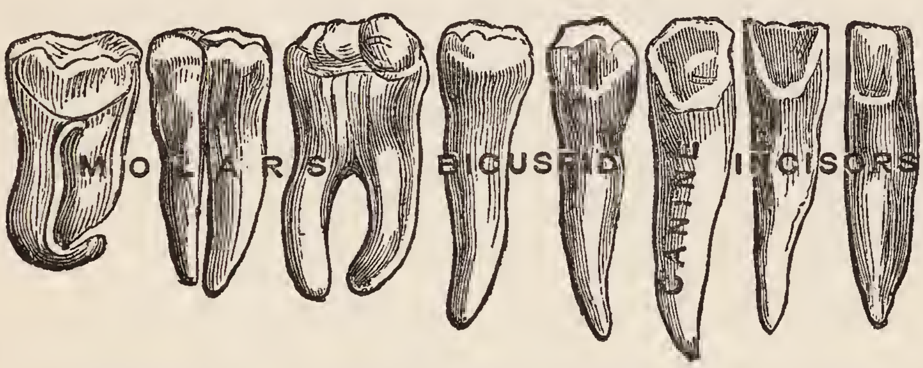


Fig. 41.—Kinds of Teeth. This figure shows the eight teeth in one half of a jaw

of the teeth is not a luxury to be confined to the rich. It is a habit to be practised by every self-respecting boy or girl in any station in life, and as far as the children in our public schools are concerned, the habit must be formed largely under the stimulus of the teacher. For actual use, besides a brush, all that is needed is a cup of lukewarm water, to which a pinch of borax may be added with advantage.

Toothache is very common among young children at school as a result of decay of the teeth, and may prove a cause of really poor health, the victims often appearing dull and listless after a broken night's rest. Let the teacher emphasize the fact that cleanliness of the teeth will largely banish toothache, and this will prove a powerful incentive to the use of the tooth-brush. A simple means of relieving the aching is to apply to the decayed tooth a little dry powdered bicarbonate of soda (baking-soda); it is often efficacious, and a little can easily be kept in school for this purpose.

The necessity of caring for the teeth of school-children as one cares for their eyesight, has been gaining ground of late in many schools, especially on the Continent. To give an example: in 1902 a dental dispensary for the care and treatment of the teeth of children in the public schools was opened in Strasburg. Attendance is compulsory, and the children are treated free of charge. In the first year 5343 children were examined, and 2666 received treatment. In the year 1904 there were paid to the dispensary 12,691 visits, and 6282 children were treated, for whom 7065 teeth were filled, and 7985 teeth were extracted, while 4382 other children had their teeth examined. The children are taught to clean their teeth three times daily, especially before going to bed. The dentist also instructs the children in the use of the tooth-brush, each child receiving a brush for home use. Since the introduction of this treatment there has been a marked improvement in the general health of the public school children. Since the foundation of the Strasburg dispensary, similar establishments have been opened in Darmstadt, Mulhausen, and other cities in Germany.

Juvenile Smoking.—A social evil which has attained grave proportions during recent years is the use of tobacco by children. The habit is confined almost entirely to boys, and the form in which the tobacco is used is chiefly the cigarette. It is a practice which has grown up mainly in the last ten years, and so serious has the risk to health appeared, that it has been deemed wise to legislate with regard to the matter. A Select Commission of the House of Lords heard much evidence on this subject last year, in order to make some definite suggestions, and all who gave evidence concurred in the bad effects of tobacco upon young growing lads. It may be laid down as a safe dictum that if tobacco is to be used at all, its use should be postponed till twenty-one years of age.

Bad Effects on Bodily Health.—In giving evidence before the Commission, Professor Sims Woodhead of Cambridge stated quite clearly that tobacco interfered with the development of the growing child. Nicotine, one of the very active chemical

substances in tobacco, first stimulates and then depresses the nerve-cells. The heart tends to slow down because these nerve-cells do not control it properly. It does not give a full beat, and the blood is not driven through the body so forcibly. The functions of nutrition, of respiration, and of the blood-vessels become interfered with, and there are alterations in the secretions of the mucous membranes. Professor Woodhead stated further that tobacco affected the function of vision, interfering with the perception of colour and with the field of vision. Sir William Broadbent stated that cigarette-smoking was the worst form, because the smoke was inhaled. In addition to the bad effects on the circulatory and nervous systems, tobacco in boys tended to cause indigestion. It is easy to understand from these facts why youthful smokers should be stunted and often pale. Mr. A. P. Saunders, a retired schoolmaster in Stafford, said he could pick out the smokers in a class, suffering from "tobacco-heart", by the poor and flabby character of their handwriting. Dr. Macnamara, as well as others, pointed out that physical deterioration was not going on in girls as it was in boys, and stated that one of the leading causes of this was the almost entire exemption of girls from the smoking habit.

Adverse Effects on Mental Powers and Moral Nature.—The powers of concentration of attention and of memorizing are distinctly impaired in the young smoker, partly due to the direct poisonous effect of nicotine on the brain-cells, partly to the lessened nutrition and circulation, whereby the brain is inadequately nourished. The moral effects are also bad, as it encourages deceit, leads not infrequently to dishonesty, and paves the way to the acquirement of other vices, such as drinking.

Lines of Legislation.—In August, 1906, the Select Commission issued their report. Two Bills had been under consideration—one introduced by Sir Ralph Littler, the other drafted by Lord Reay, Chairman of the Middlesex Quarter Sessions. The Committee recommended that legislation should proceed on the lines of Sir Ralph Littler's Bill, in so far that they considered that any person using tobacco under the age

of sixteen should be guilty of an offence, and liable to punishment under the Juvenile Offenders' Act, or to a special penalty under the new Bill. The Committee made some additions as follows:—(1) That powers should be given to police-constables to stop all youths who appear to be under sixteen years who are found smoking in public places, and that police should also be empowered to confiscate any tobacco found on these youths; (2) that permission should be given to local authorities enabling them to extend these powers to park-keepers, schoolmasters, and others, by means of by-laws, and that similar powers might be given to railway and dock companies, the exercise of which would be restricted to their own premises; (3) that some provision should exempt children who are genuinely employed by their fathers to fetch tobacco for them; (4) that the Act should apply to all children apparently under sixteen years of age.

School teachers have many opportunities of stopping this bad habit, and if at least headmasters were entrusted with the powers defined above, much could be done to lessen this growing evil.

The Teaching of Hygiene to Children at School.—There is at the present time a vast amount of preventable illness and death among the poorer classes of society, and one of the means by which this unfortunate state of affairs can be remedied is the teaching of hygiene at school to all children. What is it that we should aim at in a hygienic education? It should be, to quote Sir John Simon, "that education which by model and example would lead the poorer classes of society to know cleanliness from dirt, decency from grossness, human propriety from brutish self-abandonment, . . . an education which would teach them to feel the comfort and profit of sanitary observances, and would apply their instincts of self-preservation to the deliberate avoidance of disease".

Although we may agree about the value of giving children instruction in hygiene, we may not feel at all sure how far to go, what to omit, what should be most distinctly enforced. In the section of State Medicine at the British Medical Association Annual Meeting in 1905, Professor Kenwood of Uni-

versity College, London, read a paper on "Hygienic Training and Teaching at School", which contains so many useful hints that I shall largely quote it here. He points out that the teacher can do much by precept, example, and personal influence to create "a sanitary conscience" in the children. For this purpose he must enlist the co-operation of the parents in the home, and should even bring his personal influence to bear upon them in certain cases. The observation of sanitary rules and principles is largely a moral one, and all good will be undone if the home influence is antagonistic to that of the school. A dirty ill-cared-for child indicates bad home influence and treatment, and while this lasts little good can be expected from school training.

The teaching in all cases should be simple. It is almost sufficient, says Professor Kenwood, to impress upon the scholar certain rules on healthy living, and to give reasons for them; and at the same time to train him in hygienic habits while at school. The more formal instruction could be conveyed at the cost of half an hour, once (or possibly twice) a week during the last two or three years of school life. The teaching must deal with the simplest, the most easily understood, the cheapest and most practicable means of translating sanitary precepts into practice, not losing sight of the fact that it is the positive rather than the negative which must be presented to the scholar. The subjects round which instruction ought to centre are, the person and the home, and the aim of the teacher should be to instil the elementary principles of hygiene relating to these. The matters, accordingly, says Dr. Kenwood, on which the children should be instructed are: The importance of and the way to secure:—

1. Fresh air.
2. Cleanliness of surroundings.
3. Cleanliness of person (body, teeth, hair).
4. Cleanliness of habits (spitting, &c.).
5. Healthy bodily functions (regularity of bowels, &c.).
6. Suitable clothing (sufficient protection, woollen garments next to skin, &c.).

7. Food (clean utensils, protection from dirt and dust, &c.).
8. Temperance in alcohol.

To this might be added, for the special needs of girls (who are to be the future housewives and mothers)—

9. The selection of food, marketing, and elementary cooking, namely, the preparation of simple dishes by the simplest means.
10. How to feed and manage babies.

In concluding, it is pointed out that the singling out of one or other of the scholars for some special duty makes a strong impression on the rest of the class. For this purpose it is suggested that in each class a member should be selected as sanitary "monitor" for the week. His duty when in office would be to attend to the class-room ventilators, to open doors and windows widely at intervals, to prevent accumulation of dust, torn paper, and the like, and to see that sanitary conveniences were kept in proper order. If these hints were acted on, and instruction conveyed on the lines just suggested, children would obtain a really valuable hygienic education.

The Teaching of Temperance as regards Alcohol.—The necessity for special instruction on the harmful results which follow indulgence in alcohol is felt very keenly by many interested in the training of children. Alcohol is, to quote the words of the report of the Committee on Physical Deterioration, "a most potent and deadly cause of physical deterioration". Let me quote from a circular recently (1906) drawn up by Professor Matthew Hay, of Aberdeen, for the Public Health Committee of that city. After a few introductory words he says: "Alcoholism shortens life. The mortality among abstainers is only about one-half to one-third of the mortality among persons in occupations where drinking is prevalent. It causes many serious illnesses . . . and greatly reduces the chances of recovery. It is one of the most common causes of insanity. Its effects may descend to the children, in whom bodily and mental weakness and disease may be the result of alcoholism in the parents. It brings misery to the

home, neglect of duties, and disinclination for work. It is an active cause of loss of employment, and of poverty. It is the chief source of crime. In short, alcoholism is one of the greatest enemies to personal health, to family happiness, and to national prosperity."

These facts become painfully evident to those who teach in schools in the poor districts of our great cities, and in every class there will be found children who come from homes made miserable and poverty-stricken through alcoholic indulgence. With such sad object-lessons before one, and with the common knowledge that everyone possesses who goes through the world with open eyes, the teacher should have no difficulty in giving simple yet forcible instruction on the beneficent effects of temperance, and on the physical, mental, and moral degradation which alcoholism brings in its train.

CHAPTER VIII

The Simpler Ailments of Children—Common Colds of the Throat and Nose—Cough—Indigestion—Diarrhœa—Worms—Headache—Backache—Toothache—Chorea—Nail-biting—Nose-bleeding—Chilblains—Skin Affections—Nettle-rash—Lichen—Warts—Burns and Scalds—Remediable Bodily Deformities.

It is not for one moment suggested that school teachers should take the place of medical practitioners. They have quite enough work of their own to tax fully their mental and bodily strength, and in certain circumstances their advice in illness might easily be productive of more harm than good. At the same time it is but right that the teacher in an elementary public school should know something of the simpler ailments, of which he or she is bound to find instances among the children, and should be able to make some simple suggestions as regards treatment, or better still, prevention. Indeed, in not a few cases, if the teacher does not interest himself no one else will, and no member of the teaching profession who has the welfare of the children really at heart can stand by and see a

child in class suffering day after day from some minor yet disturbing ailment for which relief could easily be obtained. It is proposed in this chapter to discuss a few of the ordinary illnesses or troubles of children at school age which are generally regarded as non-infectious. In a subsequent chapter full attention will be given to the infectious fevers, parasitic affections of the hair and skin, contagious inflammation of the eyes, and tubercular disease. Affections of the eyes, ear, and throat, in special relation to vision, hearing, and voice-production, will also be dealt with in a separate chapter.

Common Colds of Nose and Throat.—Affections of this kind are very common in winter and spring, and are characterized by irritation in, and excessive secretion of mucus (catarrh) from, the soft lining mucous membrane of the nose and throat. The eyes are affected too, become tender, and water readily. There is sneezing, cough, and running at the nose, generally headache, and sometimes a little fever. In all probability nearly every cold of this kind is due to infection, and is in its turn infectious. It can be communicated to a neighbouring child by contiguity (through sneezing), by interchange of handkerchiefs, and possibly also by exchange of slates. Prevention consists largely in seeing that children keep their feet as dry as possible and leave damp garments in the cloak-room, a counsel of perfection where the child has no boots and no overcoat or cloak. The accumulation of dust and the presence of draughts also favour the onset of colds, and should be avoided. Healthy children can be so far protected by setting a child so affected at a dual desk entirely by herself, and by strictly prohibiting any exchange of pocket-handkerchief or hat. If the child seem feverish the teacher should advise that he or she be kept at home for a day or two. Simple home treatment, especially a day in bed to obtain an equable temperature, will generally lead to speedy recovery. There is a popular expression that these colds "run their course", which has a good deal of truth in it. If the child continues at school with some catarrh of the throat, a teacher may safely recommend a little gargling with alum and water (weak).

Cough.—This may prove very disturbing in class, and may proceed from a variety of causes. It is, indeed, rather a symptom than an actual illness. As already stated, it occurs in colds in the head and throat, but it is met with as well in nearly all lung troubles, whether of a mild or serious kind, such as bronchitis, inflammation of the lung, and consumption. It is not infrequently due, in the case of children, to irritation in parts of the body not connected with the throat or chest, as, for example, from the cutting of teeth, indigestion, or foreign substances introduced into the ear. Repeated and frequent coughing is certainly a great annoyance in class, and in many cases can be lessened by some restraint and self-denial on the part of the scholar. When children have much cough, with expectoration, and signs of weakness and fever, the teacher's effort should be to have the child kept at home and medically attended, or, if the parents are too poor, to have it taken by its mother to a dispensary or hospital. Expectoration or spitting on the floor must be strictly forbidden, as the mucus expelled may contain myriads of germs capable of causing disease, which are disseminated through the air and inhaled by others when the expectorated matter dries. This is the chief way in which ordinary consumption is spread.

No treatment for cough in school hours can be attempted, or indeed should be. The teacher, in the fulness of her heart, and to spare her own ears, may give some simple soothing sweet such as a glycerine or black-currant jujube, and this, if it accomplish no good, will certainly do no harm, and will no doubt be very acceptable to the affected scholar.

Indigestion is quite common among children, but is fortunately, as a rule, of the acute variety, due to some definite cause, and easily got over. It is generally caused by excessive indulgence in sweets of doubtful quality, or by the consumption of over-ripe fruit bought from barrows on the street, or from the child eating articles at home totally unsuited for a youthful stomach. The scholar complains then, it may be, of nausea, pain and discomfort in the stomach, of giddiness and headache, perhaps. The attack culminates in definite sickness,

when, the irritating food being ejected by vomiting, the child quickly gets well. Should sickness persist, the child must be sent home. The teacher may usually recommend with propriety a dose of rhubarb powder (Gregory's Mixture).

Diarrhœa.—This, like acute indigestion, is usually due to unsuitable and irritating food, and is very common in hot weather in large cities. Under these circumstances a mild dose of castor-oil or rhubarb powder, to clear the noxious substance from the bowels, may safely be advised, the child thereafter to be kept on boiled milk-food for a day. In other instances, however, diarrhœa may continue for weeks in a moderate degree, and be a symptom of serious illness, such as consumption of the bowels. In these cases there are other signs of failing health, and the teacher should endeavour to send word to the parents to have the invalid medically attended to. While diarrhœa is the more troublesome complaint in class, *constipation* may call for the teacher's attention. When a child is dull and heavy, and complaining of headache, with want of clearness in the eye, and with a disagreeable breath, it may well be that it is constipated. It is an important item in simple teaching of hygiene to children, to inculcate the importance to health of regular habits as regards the action of the bowels. The child may understand this, but may become very constipated, and suffer from symptoms which he does not attribute to this interference with regular habits. In such cases a line should be sent home with the scholar pointing out that he requires a good dose of some simple aperient.

Worms.—Children are very often troubled with intestinal worms, either the small white "thread-worm", about one-third of an inch long, or the much larger brown "round-worm", about 12 inches in length. They may be taken into the system from their eggs being in drinking water or adhering to vegetables which have been eaten raw. They cause uneasiness in the bowels, capricious and often voracious appetite, and general irritability. A common sign is the picking of the nose which children indulge in when suffering from these

pests, or scratching of the hips. Simple treatment by appropriate medicine at home may put the child right in a week, and in such cases it would be a kindness if the teacher sent word to the mothers as to what was suspected.

Headache, like indigestion, is a symptom rather than a disease, but it is a symptom so trying that it becomes in itself almost an illness. Headache may arise from many causes in school life. Acute attacks are met with in indigestion, feverish colds, influenza, and at the onset of many of the acute infectious troubles, such as scarlet fever and diphtheria. Chronic or more or less persistent headache may be due to a badly-ventilated class-room, or to a slight escape of gas, or to defective drains —conditions entirely outside the child. On the part of the scholar himself, a fertile source of headache is defective vision, a point to be discussed at greater length later, while anæmia or bloodlessness usually causes headache as one of its symptoms. Almost all weakly, underfed children getting insufficient rest, suffer to some extent from headache. Where the cause lies outside the child it can be remedied by abundance of fresh air, by well-lighted rooms, and by good drainage. Defective eyes are now usually detected and subjected to appropriate treatment, while in the case of anæmia a course of some simple preparation of iron will usually restore health. Anæmia, besides causing headache, leads to breathlessness and languor, and is often accompanied by indigestion and constipation. The sufferer from it betrays herself by her white face. While it is, in general, most inadvisable for a teacher to suggest a course of regular medicines, no harm can result from counselling a parent to give a young child in this condition a tea-spoonful of Parrish's Syrup (compound phosphate of iron) three times a day for a couple of weeks, or to an older boy or girl a Blaud's pill (carbonate of iron) in the same way. Boys, except when quite young, do not suffer nearly so much from bloodlessness as girls.

Backache. — Young growing children often complain of aching backs, due to the fatigue of the muscles in trying to keep the spine erect and straight. If general health be poor,

the aching is more accentuated. It leads the child to assume careless and lolling attitudes for the sake of ease, and these attitudes in their turn predispose to curvature of the spine and prominence of one shoulder. The cause, in part at least, cannot be remedied at school, for it lies, it may be, in an inherently poor physique, defective nourishment, and a dark and ill-ventilated home. Much, however, may be done to strengthen the back-muscles by suitable graded exercises. As pointed out in Chapter VI, muscles have a great power of increase in strength and firmness if judiciously exercised, and the thoughtful teacher will pay special attention to the boys or girls who complain of a tired back and show it in their attitude.

Toothache.—This has been already discussed in Chapter VII. It constitutes a trying though trivial ailment in school life, and the writer has known of instances where the health of children has been impaired by it (fortunately but for the time), on account of the broken sleep it causes. In speaking of the care of the teeth, reference was made to the value of a daily brushing in preventing toothache, and the good that sometimes follows an application of baking-soda. The use of strong remedies, such as creosote and oil of cloves, to dull the pain should not be countenanced, as they destroy the teeth. If the aching persist, the teacher might advise a visit to the dental hospital.

Chorea, or St. Vitus's Dance, ought not to be included in minor ailments of school life, perhaps, as it is an illness of some importance. But in its early stages it may be very slight, and children may attend school for weeks with it before notice is taken of it, or at all events before it is recognized that it is a definite illness. It is met with chiefly between the ages of five and fifteen, and is more common in girls than in boys, and affects the lower classes of society more than the upper. It is characterized by irregular involuntary contractions of the muscles, by some psychical disturbance, and by a special liability on the part of the patient to acute inflammation of the valves of the heart. There is generally considered

to be a definite relationship between chorea and rheumatism, at least by English and French authorities. Highly-strung, excitable, nervous children show a special liability to the disease. It is specially mentioned here because of the important influence which education may have on its onset. Especially in the case of girls between ten and fifteen years of age is the strain of education a most important factor in causing the disease. Professor Osler of Oxford says (1901):—"Bright, intelligent, active-minded girls from ten to fourteen, ambitious to do well at school, often stimulated in their efforts by teachers and parents, form a large contingent of the cases of chorea in hospital and private practice. Sturges has called special attention to this *school-made* chorea as one serious evil in our modern method of forced education."

In mild cases the twitching is slight, the speech hardly affected, and the general health practically unaltered. There is a tendency to emotional disturbance, such as bursts of weeping, night-fears, and the like. Headache and indigestion may occur. The condition has been aptly described by the term "fidgets". The teacher is very apt to consider such a child wilfully restless, and must bear in mind the possibility of chorea being present. What strikes one in such a case is the utter purposelessness of the movements. They are not those of the naughty, restless child playing with a pencil, a slate, a button, or a halfpenny merely to amuse himself. In this latter case the movements have some object; in the choreic child they have none, being merely irregular, twisting, jerky, muscular contractions beyond the child's control. They generally begin in the arms and hands, spread to the face, and then to the legs, and occur as a rule on both sides of the body. In the case of the face the twitching produces, in some cases, most peculiar grimaces. The writer remembers a case of a young school-girl who made the most extraordinary contortions with her facial muscles, for which she was constantly being corrected, while all the time she was suffering from chorea. In severe cases the movements may be so bad that the child cannot feed or undress herself, or even go about, and

the speech may be seriously interfered with. Those cases are too ill to come to school, but mild cases may and do attend; and if any suspicion be aroused in the teacher's mind that the child be suffering from some nervous ailment, it should be sent home, with a message to the parents to take it to hospital or have a doctor called in. It is very important that these cases should be treated properly, in order to lessen the chance of the occurrence of heart-disease. That the latter is only too apt to occur and to persist is borne out by the fact that of 140 cases examined more than two years after the attack, 72, or 50 per cent, were found by Professor Osler to have organic (permanent) heart-disease. The possibility, therefore, of this disease being present must be borne in mind, both to prevent injustice being done, and to obviate, if possible, the risk of the affected child acquiring an incurable heart-illness.

Nail-biting is a habit of nervous origin in many cases, that must be stopped when met with. It is not an illness like chorea, is associated with no complications, and can be treated both by physical and moral methods. It sometimes happens that two or three repetitions of suitable punishment are sufficient to break the habit. In other instances it is done practically unconsciously, and in such cases the child should be made to punish itself. This is best effected by smearing the finger-tips with some disagreeable substance, so that when they are, almost automatically, applied to the lips, the culprit may be at once reminded of his lapse in a sufficiently disagreeable manner. One of the best remedies is strong Barbados aloes, bought as a powder, and rubbed thoroughly into the finger-tips and round about the nails. I have yet to see the child who enjoys removing the bitter, somewhat nauseating dust with his tongue! The habit of nail-biting is not only ugly, but it spoils the nails, and may be the means of conveying infection to the mouth.

Nose-bleeding. — Children not infrequently are troubled with this in class, especially during hot weather. The blood-vessels on the mucous lining of the nose are easily ruptured in children, under any strain, and an attack of nose-bleeding

follows. It is favoured by a hot and close room, by a stooping posture, and by tight collars or neck-bands. In some cases it is preceded by severe headache over the forehead region, which is relieved when the bleeding occurs. Bleeding from the nose is usually stopped with reasonable ease, the best procedure to adopt being to seat the child on the floor with his back reclining against the wall, and to hold the nose, making the child breathe quietly through the mouth. A handkerchief wrung out of very cold water may be pressed to the root of the nose or to the nape of the neck. As the bleeding ceases, the nose becomes filled up with clots of blood, which act as Nature's plugs, and should not be disturbed by blowing the nose (at least for an hour or two), although they may feel uncomfortable. A simple remedy which sometimes is useful is powdered galls, a little of which may be snuffed up into each nostril. Occasionally, bleeding from the nose persists for a long time, and may prove very exhausting and even dangerous. In such cases it would be better not to attempt to send the child home, but to summon the father or mother, entrusting the child to their care, and recommending them to take it to the nearest hospital or dispensary, for which the use of an ambulance may be needful.

Chilblains are another affection connected with the circulation that may cause a good deal of discomfort in school life. They affect both fingers and toes, as well as the ears, making the parts red or purplish-red, swollen and hot, with a great deal of irritation, and even burning pain. They are commonest in winter, and occur more among girls than boys. They always indicate a defective circulation, but in addition a poor physique as well, and insufficiency of vital power. They are much aggravated by heat, as by sitting near a fire, and taking active exercise, and may form an ulcerated surface, the so-called "broken chilblains". They make the winter a misery for poor children, and distract their attention in class by their intolerable itching. The best treatment is preventive—good boots and stockings, and plenty of good food. This is beyond the teacher's duties. What does do some good, and may be

permitted in school if a teacher will be so kind as to do it, is painting the chilblain, either with tincture of iodine or friar's-balsam. The wearing of worsted mittens or cuffs lessens the chances of their appearance on the hands.

Skin Affections.—The sensitive skin of the child is very susceptible to adverse influences, and readily shows patches of redness, blotches, and other marks, as the result either of external irritation or of internal disturbance. Among the most important affections of the skin during school life are those due to skin parasites—animal or vegetable,—which will be considered under *infectious* ailments. There are various other affections of the skin which cannot be handed from one child to another which may distress them and detract from attention in school. One of these is *nettle-rash* or *urticaria* (Lat. *urtica*, a nettle), which is characterized by the appearance, sometimes quite suddenly, of "wheals" somewhat similar to those produced by the common stinging nettle. The wheal is raised above the skin surface, is round, oval, or irregular in outline, and has a red margin with a white blanched centre. Before the eruption appears there may be some feeling of headache or sickness; after the rash is out, there is great heat and itching, accompanied by an overwhelming desire to scratch. The site of the wheals is commonly the face, and any other parts where pressure is exerted by clothes. A common cause is the bite of some insect, while it is well known that certain articles of food readily produce nettle-rash in persons with a predisposition to the illness. One article among others that is notable for causing this, is mussels and cockles, and children who may buy these delicacies off barrows on the street may suffer from a sharp crop of wheals. The latter sometimes appear quite suddenly, from no apparent cause, and disappear as unexpectedly. The complaint may make children very irritable at school, while not considered serious enough to keep them at home. The teacher might safely suggest bathing with *cold* water containing a little borax, and after drying, dusting with ordinary baby's violet powder. A dose of a mild aperient is often of much service.

Heat-spots, as they are popularly termed, a variety of the skin affection known as *lichen*, and allied to the nettle-rash, is a very common complaint among young children in the infants' school, and may make them very restless. They appear as hot-looking, red, inflamed patches, slightly raised, found on the arms and legs, chest and back, showing distinctly against the whiter skin. They are very irritating, and children may scratch them till the skin on the top is broken and a scab forms. They are nearly always, in my experience, associated with digestive troubles, and are aggravated by the taking of sweets. If a teacher has the opportunity of saying a word to the parents, counselling very simple diet (chiefly milk) for a few days, with a small dose of compound rhubarb powder (Gregory's Mixture) and baking-soda—as much of each as will lie on a threepenny-piece—each night at bed-time, the condition usually improves rapidly.

Warts are too well known to require special description. They are horny little projections of the skin, usually seen on the hands, though they may occur on the face and elsewhere, and usually affect children more than adults. They sometimes appear and disappear in a way altogether incomprehensible. Many charms have been in vogue for their removal, and the success apparently attending the use of some of these is probably to be explained by the way in which warts vanish of their own accord. They look very unsightly on the hands of school-children. A well-meaning teacher may, in kindness, invest in a small piece of lunar caustic (silver nitrate) wherewith to touch them, but this is an unsatisfactory application, as it often merely blackens the skin and irritates the wart. A much better plan of treatment, quite easily used at school, is to apply a drop of the strongest acetic acid. Glacial acetic acid should be asked for, and twopence-worth will remove a large number of these excrescences. The only other thing required is a little tin of vaseline. Then let a ring of vaseline be painted round the wart to protect the adjacent skin, and with the end of a wooden match let a drop of the strong acetic acid be applied to the wart. This is left

on for a few minutes, and then the whole wiped off. As a rule, in the course of a few days the whole wart is dissolved away.

Burns and Scalds.—In cookery, laundry, and science classes at school, burns and scalds are not very infrequent accidents. A *burn* is caused by a heated solid body or by actual flame; a *scald* by hot liquids or steam. They are always painful, and if deep or extensive, may end fatally. In all serious cases it would be necessary to have the child removed at once, either to his home or to hospital, by the ambulance; but in slight burns much may be done at the school to relieve suffering. In every case, if the clothes catch fire, the person must be at once laid on the ground, partly because flames tend to ascend, partly because in the erect posture there is more air about the person, and consequently combustion goes on better. As soon as the child is on the ground, it should be enveloped as completely as possible in a coat, table-cover, or similar material, to extinguish the flames and exclude air. Even after the flames are out, water should be poured on to completely cool and check any smouldering. In a case of this kind, the child should be removed by ambulance as already mentioned. There are many cases, however, of minor burns and scalds which can quite well receive "first-aid" treatment at school. What one aims at is to relieve pain, and protect the skin at the affected part. Suppose it is a quite superficial burn, producing merely redness and pain; a suitable means of treatment would be to dust it thickly with flour, powdered starch, or powdered carbonate of soda, and wrap it up gently but completely in a clean handkerchief, excluding the air as far as possible. Where blistering occurs, and in burns of the more severe type, it is preferable to apply to the affected part strips of clean handkerchief coated with some oily substance. Suitable for this purpose are vaseline, olive or almond oil, glycerine, Carron oil (a mixture of equal parts of lime-water and linseed oil), and the like. Even a clean handkerchief wrung out of a solution of carbonate of soda in water and laid over the burned skin will afford relief. The whole dressing should

then be wrapped up in other coverings, and the limb, if it be the hand or arm, supported in a sling. First-aid of this kind will prove a great boon; subsequent treatment must be carried on at home or at hospital.

Remediable Bodily Deformities.—I should like in conclusion to say a few words about certain deformities or deviations from the normal as regards stature, proportion, and symmetry, which either develop or make themselves apparent in school life, and which can be largely remedied or obviated by school discipline and physical exercises. Let us first consider the spine.

Spinal Curvature.—The spine or backbone or vertebral column is made up of a considerable number of separate bones or vertebræ, there being seven in the neck region (*cervical*), twelve in the back (*dorsal*), five in the loins (*lumbar*), five fused into one mass in the *sacrum*, a broad wedge of bone fitted in between the hip-bones, while the tail or *coccyx* has four segments also united into one bone. The coccyx can move very slightly on the sacrum, to whose lower end it is fixed; the sacrum itself

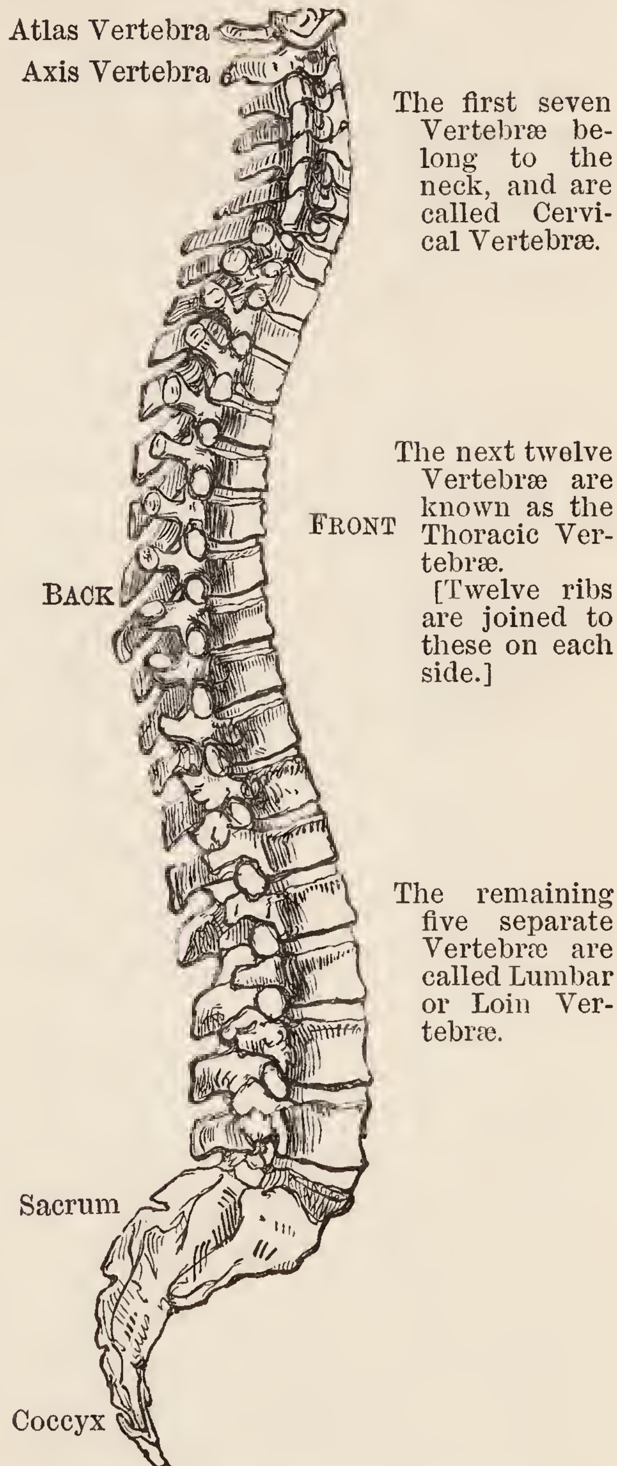


Fig. 42.—The Vertebral Column

is practically immovable; while the remaining twenty-four vertebræ are all capable of a little movement, each being separated from its neighbour above and below by an elastic plate of gristle.

The vertebral column appears, as it were, to be supported on the sacrum, and this in its turn is wedged in between the hip-bones, and lies square and even as long as the hips are kept level. Looked at from the side the vertebral column presents a series of curves (fig. 42), but viewed directly from behind it is a straight line with practically no deviation to right or left. That is, a line drawn straight down from the centre of the nape of the neck to the beginning of the fissure between the hips, follows the course precisely of the backbone (fig. 22). One of the most important deformities acquired during school life is a lateral or side curvature of the spine. It results, in part, from bad attitude in standing, whereby one leg is kept bent, so that the hip-girdle is tilted, and the spinal column does not rise from a level base, but is obliged to curve itself to meet new conditions (fig. 43). It is in the upper dorsal region that curvature shows itself most. If a series of ink dots be placed on the tips of the spines of the vertebræ in series, the line of dots in such a case will follow a curve and not a straight line from neck to hip. The shoulder-blade on the side towards which the dorsal curve is directed also stands out with greater prominence, and ribs, running round from backbone to breast-bone, also get twisted. The same sort of thing arises from a child sitting in a careless and slouching

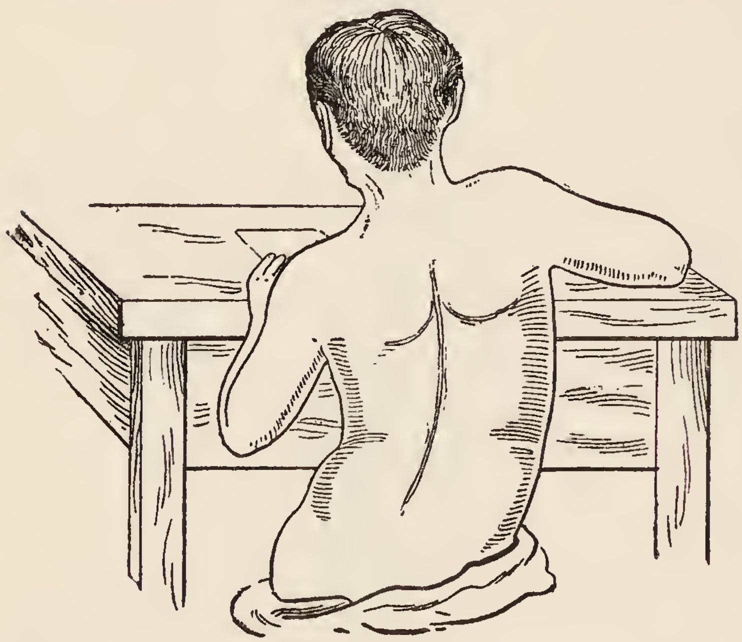


Fig. 43.—Curvature of the Spine

attitude, with the body twisted upon the hips. No very long continuation in this habit is necessary to produce deformity in the plastic vertebral column of the young. The treatment of lateral curvature is both preventive and curative. The former consists in seeing that children stand well, the feet firmly planted, the legs straight, and both sides of the hips on a level. The spine will then rise erect. In the same way, slouching and ungainly attitudes in writing and drawing should be forbidden, the child being taught to sit squarely in the seat. Curative means, as far as school life goes, consist in physical exercises adapted towards the strengthening of muscles of the back; these are to a considerable extent preventive too, and will be referred to more fully in our closing chapters.

The backbone, however, may become abnormally curved, not to the sides, but from before backwards, an exaggeration, as it were, of the normal curves in this plane. The commonest deformity is the condition of "roundness" of the shoulders, brought on by stooping—a condition in which the natural curve back of the dorsal part of the spine is exaggerated, though the column does not deviate to one side or the other. The curving back of the spine naturally pulls on the ribs, tending rather to flatten the chest from side to side, so that no child with round shoulders can have a really well-developed chest. This condition may be acquired at school. There are still greater degrees of deformity, producing an actual "hump-back", with sinking downward and forward of the head, which may date from birth, and are usually quite marked by the time the child goes to school. Ordinary roundness of shoulders may be prevented by removing occasion for stooping, by seeing that the desk is near enough to the seat, that the light is adequate and the letterpress of books clear, and that children with defective vision get glasses and wear them. In not a few cases the back-muscles seem inherently weak, and it is in this connection that the value of physical exercises becomes so important. Even if roundness of shoulders already exist, it is curable in young children by

removal of cause and by steady exercise, as the backbone can still adapt itself to new conditions.

Flat and Deformed Chest.—To some extent the chest is altered for the worse by spinal deformity, but there is a flat and narrow chest among school-children existing *per se.* This is made worse by confined and cramped attitudes, and requires to be corrected by chest- and breathing-exercises. Under the influence of these, it is wonderful how the chest acquires a good form, and how its power of expansion increases. Besides

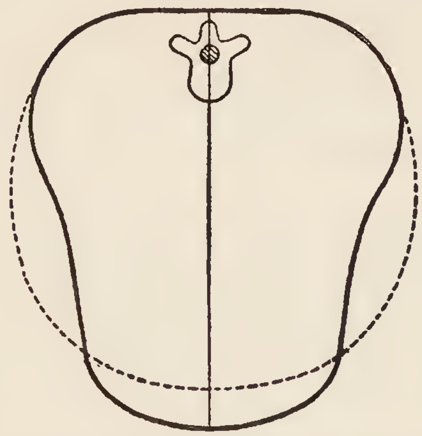


Fig. 44.—Cross-section of Rachitic Chest (Gee)

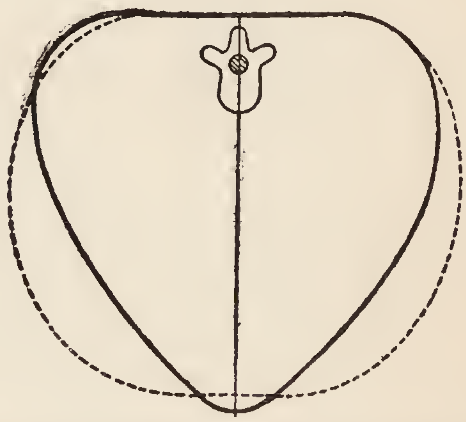


Fig. 45.—Cross-section of Pigeon Breast (Gee)

The dotted lines represent the normal outline for the same age.

the narrow or flat chest, there are two other conditions that should be mentioned: these are the *rachitic* or rickety chest, produced in earlier life when a child is suffering from rickets, and the *pigeon-breast* chest, caused by the strain of whooping-cough on young and easily-moulded ribs. The rachitic chest (fig. 44) is caused by the ribs, defective in osseous matter, bending in under the pressure of the external air. The ribs accordingly present a sort of wide shallow groove at each side, and the chest is narrowed. In the pigeon-breast (fig. 45) the breast-bone is pushed out, and the ribs flattened at the side, so as to present a contour somewhat similar to that presented by the breast of a plucked pigeon. Both those conditions are associated with defective expansion of the chest, and with a distinct tendency to lung complaints, such as bronchitis, and both require attention and correction as far as possible by

means of exercise. We want in these cases to get the ribs to curve out at the side, so that the chest may widen, and so that its cross-section should be that of an ellipse, broader from side to side than from front to back.

Flat-foot.—Our foot when we place it on the ground does not lie in contact with the latter over its

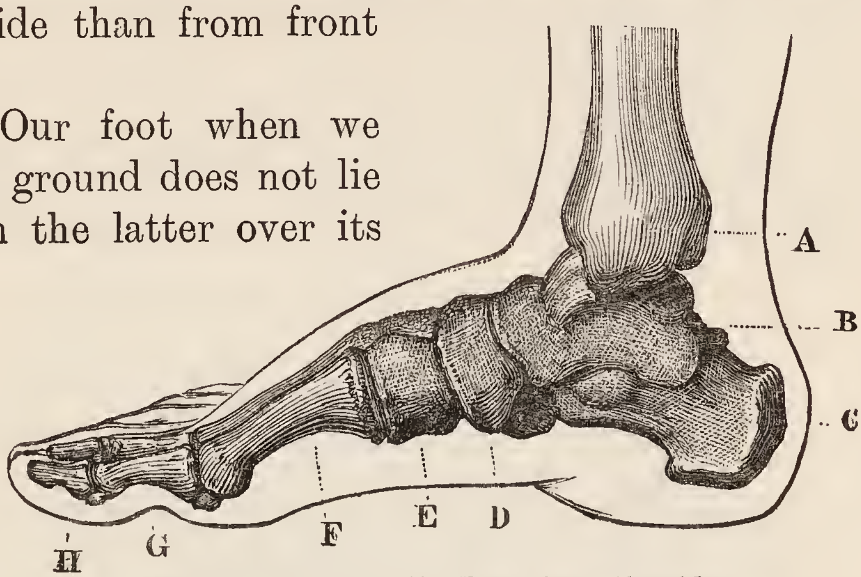


Fig. 46.—Bones of the Foot, from the side

A, Tibia; B, astragalus; C, os calcis; D and E, other tarsal bones; F, metatarsal bone of great toe; G and H, phalanges of great toe.

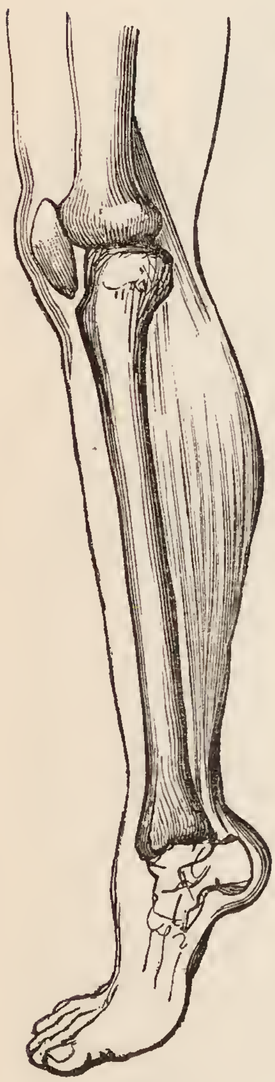


Fig 47

entire surface (fig. 46). It possesses an arch, so that the sole of the foot is partially raised above the ground. If one examines a foot-print left by a naked foot on a dry floor or pavement, one notices that an impression is made by the heel, the outer side of the foot, and the toes in part. This tells two things: first, that the foot possesses an arch, and secondly, that it is more marked towards the inner side of the foot. It is composed of the small bones of the foot, articulated together and supported by bands of strong fibrous material, as well as by tendons running to the toes. The arch gives spring and elasticity to the step, and ease and agility in walking, jumping, and dancing. Some children are born with the feet quite flat, in a few cases the sole may be even convex. Conditions which predispose to flat-foot are prolonged standing, the carrying of heavy weights,

inflammation of and injury to the small bones of the ankle and foot. A great deal can be done in the way of improvement by exercising the leg and foot muscles, and in this lies the value of many exercises where there is rising and falling on the toes and the heels (fig. 47). There is often much aching, and even actual pain, connected with flat-foot; this may be relieved by some form of pad and bandage applied to the sole, but this is a matter outwith the teacher's province.

CHAPTER IX

The Vision and Hearing of School-children—The Structure of the Eye—Normal Vision—Eye-strain and Impaired Sight—Long-sightedness—Short-sightedness—Astigmatism—Squint—The Ear—Deafness—The Throat—Enlarged Tonsils—Adenoid Growths.

Vision of School-children.—Among the more purely medical aspects of school life none has claimed more attention during recent years than defective vision. That this is a matter of vital importance none will deny, though some have thought that too much has been made of slight deviations from the normal. Be this as it may, the fact still remains that a considerable number of our school-children have more or less poor sight, that this defective vision in many instances tends to grow worse instead of better, that it leads to other conditions inimical to perfect health, and that it handicaps those who suffer from it in the struggle for existence, closing not a few portals to them. The fact that there are certain children who have not normal sight soon becomes apparent to a teacher, but there are always a few who are apt to be overlooked and regarded rather as stupid than deficient in acuity of vision. The attention that is now being paid to this subject is rendering the overlooking of genuine cases of poor vision more unlikely each year, and there is reason to believe that a time may come, reasonably soon, when all cases of defective sight will receive attention.

Structure of the Eye and Physiology of Vision

The eye (fig. 48) is roughly speaking spherical, and enclosed in great part by a strong outer coat named the *sclerotic* (H). In the front part of the eye this opaque layer is replaced by a transparent one—the *cornea* (A). Inside the sclerotic is a vascular layer containing the vessels of the eyeball and termed the

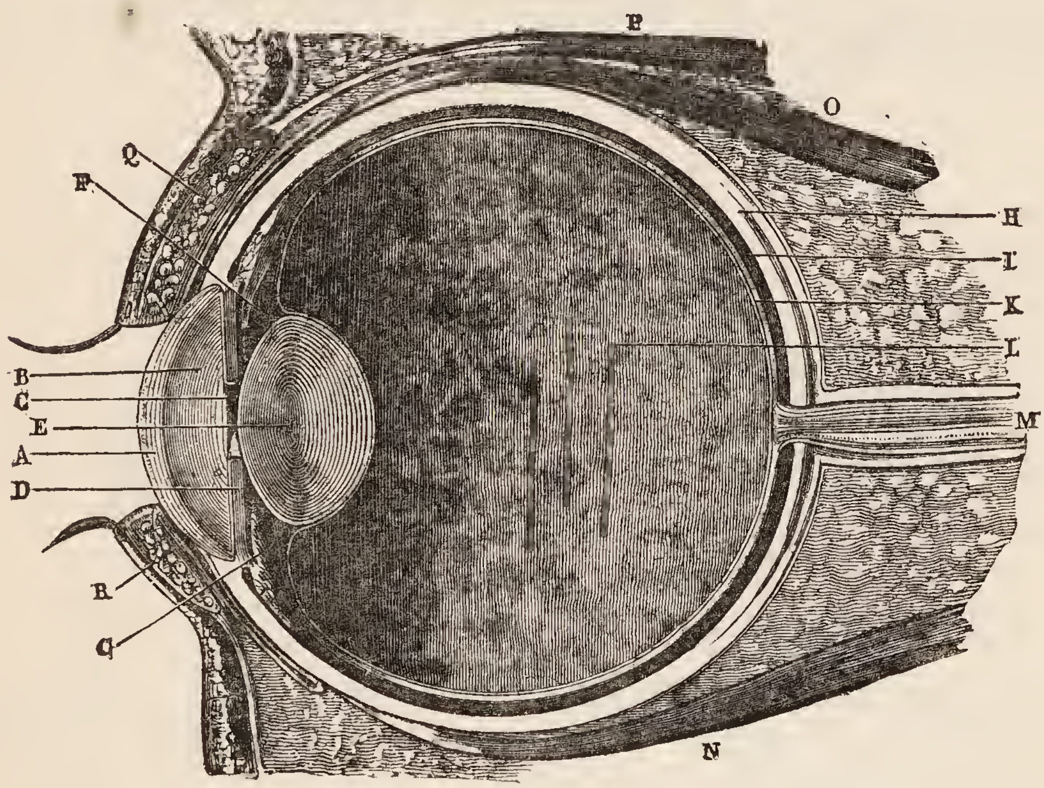


Fig. 48.—Longitudinal Vertical Section of the Eye

A, Cornea; B, aqueous humour; C, pupil; D, iris; E, lens; F, suspensory ligament; G, ciliary process; H, sclerotic; I, choroid; K, retina; L, vitreous humour, outside which the hyaloid membrane is indicated by a fine white line; M, optic nerve; N, inferior rectus; O, the superior rectus muscle; P, muscle which raises the upper eyelid.

choroid (I), while the innermost coat of all is one of great delicacy named the *retina* (K), on which light-rays entering the eye fall and become changed into nerve-impulses. In order that rays of light may be precisely focused on the retina, they pass, after entering by way of the cornea, through a crystalline *lens* (E), bi-convex in form, lying in the eyeball near its front part. In front of the lens is a circular curtain, the *iris* (D), with a round opening, the *pupil* (C), in its centre. Through

the pupil light reaches the lens, and the size of this opening is regulated automatically by the nervous mechanism of the eye, becoming smaller when the light is bright, and enlarging when illumination is dim. In front of the iris, and between it and the cornea, is the anterior chamber of the eye, containing some watery fluid termed *aqueous humour* (B), while behind the lens, and filling all the space of the eyeball right back to the retina, is a jelly-like substance, the *vitreous humour* (L). The *optic* nerve (M), or nerve of sight, enters at the back of the eye-

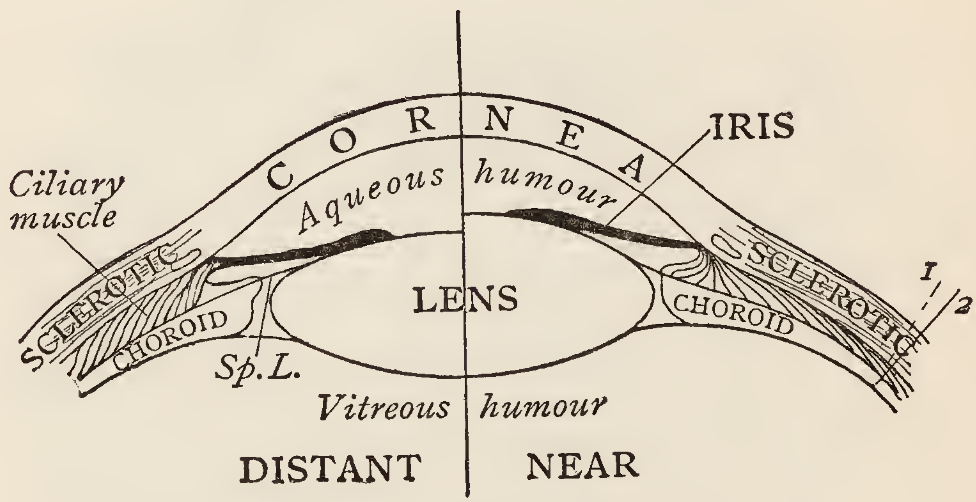


Fig. 49.—Diagram to illustrate Accommodation

On the right side the adjustment for near objects is shown, and on the left that for distant objects. 1, Position of needle pushed through into choroid coat before accommodation; 2, position of the same after accommodation.

ball and spreads out all over the retina, conveying impulses from this sensitive layer to the brain. Inside the eyeball, springing from its coats near the lens, and attached at one end near the margin of the lens itself, is a little muscle of great importance, the *ciliary* muscle (G). This is used in focusing, for when it is used it enables the lens to bulge a little, becoming thicker from front to back, and focusing rays more near to it than when the muscle is not used. The eyeball is protected in front by the eyelids, lined by a delicate soft membrane, the *conjunctiva*, very prone to inflammation. The eyelashes at the edges of the lid help to keep out dust, while the *lachrymal* gland, in the upper and outer part of the orbit, by its quiet, constant secretion of tears, washes the front of the

eyeball and keeps it and the inner surface of the eyelids moist. The excess of fluid escapes by a small tube into the upper part of the nose. Most of these anatomical points are illustrated in fig. 48.

When we regard the physiological action of the eye, we perceive that the essential thing in vision is to get a definite picture of an external object focused on the retina. Suppose we look at a distant object. The light-rays proceeding therefrom are practically parallel, and entering the normal eye at rest, are precisely focused on the retina and form a clear picture there (fig. 50, A). Such an eye is said to be *emmetropic*, and this vision is termed distant or far vision. If, however, the object looked at be brought near the eye, say two feet from it, the rays proceeding from it diverge, and in order that they may still focus on the retina a stronger lens is required (fig. 49). This is obtained by the action of the ciliary muscle, which makes the lens bulge more, or become more convex, and thus just focus these rays at the proper place; were it not so, these rays from near objects would focus theoretically behind the retina, and where they actually did fall on that membrane would produce a blurred instead of a distinct image. This special act of focusing is termed "accommodation".

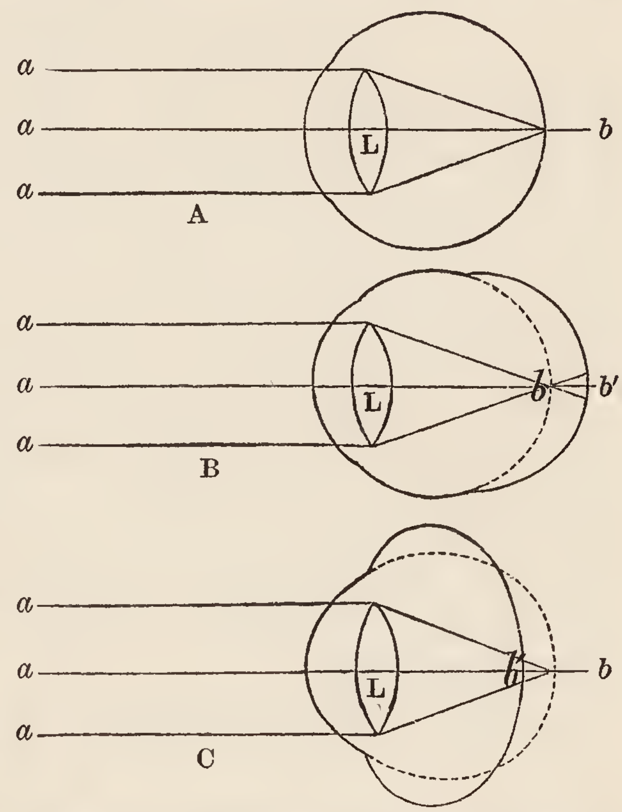


Fig. 50.—A, Ordinary Eye, rays of light *a a* from a distance coming through the lens L to a point *b* on the retina. B, Short-sighted Eye, rays from a distance coming to a point *b in front* of the retina *b′*. C, Long-sighted Eye, rays from a distance coming to a point *b behind* the retina *b′*. L is the lens in each case.

Hypermetropia.—The condition of the normal eye is thus said to be one of emmetropia. But not a few adults, and still

more children, exhibit a condition called *hypermetropia.* Now if the normal eye is just the proper length from front to back, the hypermetropic one is too short (fig. 50, C). The distance between lens and retina is too short, so that light coming from a distant object, which should produce a clear picture without any effort, is not focused at the proper point, and blurred vision results. The focus is really behind the retina (fig. 50, C). It is clear that if such an eye could be lengthened things would be all right. This, of course, cannot be done; but the same thing could be obtained if a stronger lens were inserted which would bring the focal point nearer. Now we have just seen that by the action of the ciliary muscle the lens can be made more convex (in other words, stronger). If the hypermetropic child, then, looking at a distant object, use the ciliary muscle, the rays of entering light can be focused at the proper place. This, however, implies constant muscular effort. Still more effort is required for near vision, as the divergent rays from the close object demand a still stronger lens for proper focusing. Persons with eyes of this type are called *long-sighted.*

Myopia.—In the myopic or *short-sighted* person the eye is too long from front to back, the retina thus being farther from the lens than it should be. It lies behind the focal point of the lens. The result is that if the child be looking at a distance the parallel rays entering focus in front of the retina and then cross, and finally impinge on it to produce a blurred instead of a distinct image (fig. 50, B). We have seen that the hypermetropic person can see with some distinctness at a distance if he throw his ciliary muscle into action and increase the power of his lens. But in myopia one really wants to weaken the lens, and the ciliary muscle cannot do this. When we come, however, to near vision the person with myopia sees well. If a book is held near, the divergent rays from it naturally focus farther back than do the parallel rays from a distance, and so may fall precisely on the retina in the short-sighted eye. If the myopia is great, that is, if the eye is very long from front to back, the rays from the object must be

made still more divergent if focusing is to be obtained, and consequently the book or whatever it is must be very near the eye. In many instances, especially in school life, the eye is approached to the object, a copy-book for example, and if the head need to be brought very low a bad position results, leading to further straining of the coats of the eye, with stretching of the same, which leads to further elongation of the eye, and so to increase in the myopia.

Astigmatism.—In the healthy eye the curvature of the cornea is the same in all directions, from above downward, and from side to side. Otherwise expressed, its degree of curvature is the same in all meridians. It happens not infrequently that the curvature is greater in one direction than in another, say at right angles to it. Those rays that pass through the part with the greater curvature will be focused before those that pass through that at right angles, and indistinctness of vision results. To quote the common illustration: the person so affected cannot, when looking at the face of a clock, see the figures XII and VI distinctly at the same time as III and IX. This defect is called *astigmatism*, and is associated with either hypermetropia, myopia, or both. The ciliary muscle has little power to relieve this defect, and both near and far vision are defective.

Strabismus, or Squint.—The axes of the two eyes if directed to a distance are practically parallel. When a want of the parallelism occurs a squint develops. The eyeball is moved inwards and outwards, up and down, by muscles attached to it externally. Squint may arise from *paralysis* of one of these muscles, or from *spasm* affecting one. The squint may be towards the outer side of the orbit or towards the nose. The commonest form of spasmodic squint is an internal strabismus in children, associated with hypermetropia.

Among school-children the most common defect is probably hypermetropic astigmatism, then comes ordinary hypermetropia, and then myopia and mixed astigmatism.

Occurrence of Defective Vision among Children.—Hypermetropia and astigmatism may be congenital; indeed it may

almost be said that the normal child's eye is somewhat hypermetropic, being shorter and flatter than the adult's. Dr. Priestley Smith says it does not attain its normal proportions till the eleventh year. A congenitally long eye is, however, very rare. In other words, a child is rarely myopic at birth; but nearly all authorities are agreed (1) that myopia can be acquired by children with non-myopic parents, that is, not necessarily hereditary, and (2) that once acquired it tends to increase in degree. The statistics of Germany and Austria prove that it increases as one passes from the lower to the higher standards, and in the Paris Communal Schools it was found—

That between	7 and	9	years of age	1·9	per cent	were myopic.
„	10 „	11	„	6·9	„	„
„	12 „	13	„	14·8	„	„

This increase in myopia is due to the stretching of the coats of the eyeball, allowing of elongation of the axis, and De Schweinitz has demonstrated the thinning of the sclerotic and choroid, which indicates the stretching that is going on. Near work increases the congestion of the eye and aids the stretching. In general, the bad factors are: small objects, bad light, bad type, badly-arranged desks, tight collars, and close hot rooms. In addition to local mechanical causes of myopia, Nettleship, Wray, Priestley Smith, and others point out the importance of general enfeeblement of health, acute illnesses, and deficient feeding as factors in abetting it. Of the local conditions mentioned, near reading and writing, and especially sewing and knitting, favour the development of myopia and increase it when present. The influence of sewing determines the greater amount of myopia in girls than in boys. Priestley Smith, in examining 1000 Board children, found that 7·5 per cent of the girls and 4·5 per cent of the boys were myopic. As the myopic child cannot improve its vision by the action of the ciliary muscle, it does not know what good sight is, and therefore is conscious of no loss.

In hypermetropia, which is a good deal more common than myopia among school-children, an effort is constantly being

made to strengthen the lens by the aid of the ciliary muscle. There result headache and pain in the eyes themselves, congestion and inflammation of the lids and eyes, and often some blurring of the vision, especially for near objects. These symptoms are always worse if astigmatism accompany the hypermetropia.

Miss Ettie Sayer carried out an investigation for the London Education Committee on 1864 children in elementary schools, and obtained the following results:—

Age.	Normal Vision.	Serious Defects.
6 years	81 per cent	3·5 per cent
8 ,,	77 ,,	8 ,,
11 ,,	58 ,,	11 ,,

For the Govan School Board, observations were made by Dr. Inglis Pollock, and communicated to the Royal Philosophical Society of Glasgow in December, 1905. He examined the children in three schools, making a total of 3183 cases, with the following results:—

	Fair Vision.	Defective Vision.	Myopia.	Squints.
Hillhead High School	21·6 per cent	8·2 per cent	8·3 per cent	71
Elder Park School	12·7 ,,	9·2 ,,	5 ,,	among all
Church Street School	30·3 ,,	22·2 ,,	7 ,,	the cases

He considered that about 45 per cent of the children had normal vision, the numbers ranging from 38·5 to 52 during the various school ages. Of all the scholars, 12 per cent had hypermetropic astigmatism, and when they reached 30 or 35 years of age were obliged to use glasses for near work. The amount of myopia was considerable, especially at Hillhead School, but this was explained by the large number in the secondary school. The percentage of myopia began at 1·7 at the age of 5, and rose steadily to 8·4 at 13 years of age, and thereafter rose with a bound to 25 per cent at 18 years of age. This was attributed to the withdrawal at 14 years of age of non-studious children, leaving only those working for the University or Training Colleges. There were, as noted above, 71 squints among the 3183 children; these cases, said Dr. Pollock, should

be treated as early as possible, otherwise the squinting eye in many cases might lose vision almost entirely.

Observations on a still more extended scale were carried out for the School Board of Glasgow by Dr. Wright Thomson, chiefly during the year 1905, and were embodied in a full report issued in September, 1906. The report contains so much that is of interest, that the summary and conclusions will be given in detail, supplemented by some explanatory notes.

1. The teachers received instructions for testing the eyesight in the manner to be described later, and ascertained the visual acuteness of 52,493 children, among whom they found 18,565, or 35 per cent, to be below what is regarded as the normal standard.

2. Dr. Thomson examined the 18,565 defective children by a special method, viz. *retinoscopy*, and found that 11,209, or 21 per cent of the whole, had ocular defects. This latter term includes those defects in the eye, regarded as an optical instrument, which we have just considered—hypermetropia, myopia, astigmatism,—and such defects are revealed not by testing the eyes as regards mere vision, but by examination by special means, as in retinoscopy.

But, it will be asked, how came it about that the teachers found 18,565 children with defective vision, while the oculist only obtained evidence of ocular defect in 11,209? This is because the teachers tested the children by trying what letters of a given size could be read at a certain distance, and some children with normal eyes could not answer to that test. For the act of vision is not ended when the picture produced by the entering rays is focused on the retina. The retinal impression has to be carried by the nerve of sight (optic nerve) up to the brain, to the sight-centre, and to the higher intellectual centres and there interpreted. This has to be kept in mind in testing children, especially young children, by means of letters. For the recognition of a letter is a mental process or act, and a child may see a letter distinctly enough as a picture, that is, may have no ocular defect, yet may not interpret the image in the brain correctly, and so be considered to

have defective vision. Hence it is that those with defective vision always outnumber those with ocular defects.

3. The percentage of ocular defects was fairly constant in all the schools, but the percentage with defective vision was very variable, *i.e.* many children with normal eyes were found to see badly.

4. The proportion of these cases was highest in the poor and closely-built districts and in old schools, and was lowest in the better-class schools and in those near the outskirts of the city.

5. The proportion of such cases in the country schools of Chryston and Cumbernauld was much lower than in any of the city schools; and in Industrial schools, where the children are fed at school, the proportion was lower than among Board School children of a corresponding social class.

6. Defective vision, apart from ocular defect, seems to be due partly to want of training of the eyes for distant objects, and partly to exhaustion of the eyes, which is easily induced when work is carried on in bad light, or the nutrition of the children defective from bad feeding and unhealthy surroundings. The better sight of country children (section 5) is due in part to the constant use of the eyes for long distances, while that of Industrial School children is attributed to better feeding.

7. Regarding the training of the eyes for distant objects, much might be done in the Infant department by the total abolition of sewing, which is definitely hurtful to such young eyes, and the substitution of competitive games involving the recognition of small objects at a distance of 20 feet or more.

8. Teachers can determine the visual acuteness, but they cannot decide whether or not an ocular defect is present.

9. Visual acuteness, especially among poor children, is variable at different times.

10. Teachers should have access to sight-testing materials at all times, and should have the opportunity of referring suspected cases for medical opinion.

11. An annual testing by the teachers, followed by medical inspection of the children found defective, would soon cause

all existing defects to be corrected, and would lead to the detection of those which develop during school life.

Such are the conclusions of Dr. Wright Thomson, and though they have been subjected to some criticism, chiefly on the ground that you cannot lay down precisely what is a normal eye for a child, since most of children are hypermetropic, yet in the main they agree with the conclusions of other oculists who have given attention to the matter.

Making an approximate average of the number of cases of eye-defects from Dr. Wright Thomson's report, it is found that the percentages are as follows:—

1. Those with vision of both eyes very bad ...	...	10·32 per cent
2. Those with hypermetropia distinct or great	...	6·63 ,,
3. Those with hypermetropic astigmatism ...	...	9·17 ,,
4. Those with myopia	...	1·57 ,,
5. Those with myopia and mixed astigmatism	...	2·88 ,,
6. Those wearing glasses	...	2·21 ,,

There were on an average some eight or nine cases of squint in a school of 800 pupils.

Methods of Prevention.—Some of the causes that lead to defective vision, and increase existing ocular defects, have been already referred to. The means by which sight may be conserved and improved are as follows:—

1. An ample supply of light, from large windows with good transparent glass.

2. Light from the proper quarter, left side, or left and right combined; never from the front. In the case of artificial lights, the burners should not be too high above the scholars' heads, and slightly in front of them.

3. Desks of proper construction, as described in Chapter IV, so that the edge next the child is nearly vertically over the free edge of the seat.

4. Walls of a quiet and restful colour, such as a grey-green.

5. Paper of books to be a good white, and quite opaque, with clear well-cut type.

6. Black-boards to be of a true black, not a brown-black, and the chalks of good colour.

7. Ventilation to be very thorough; hot close air causes congestion of head and eyes alike.

8. Tight collars to be discontinued.

9. Near work, such as sewing, to be discarded for young children, and town children in particular to be trained to use their eyes for long distances.

10. Stooping at work to be stopped; the eye must not be nearer the book or slate than *ten* inches.

11. Juvenile smoking to be stopped.

If these points could be attended to, there would be a great deal less defective vision than exists at present.

Actual Means of Treatment.—This naturally consists in having ocular defects remedied by means of proper glasses, ordered by an oculist, not by a spectacle-maker. The hypermetropic eye must have its focusing power increased by a convex lens placed in front of it. The myopic eye requires to have its focus moved farther back, and this is accomplished by the wearing of a concave lens. In astigmatism the defective curvature must be remedied by a lens cut in a special fashion, while squint requires appropriate treatment. Now these active measures can only be initiated after the children with defective vision have been picked out, and this accordingly is the first thing to do.

How to Test the Eyesight of School-children.—For this purpose a test-card is employed. This is a card with a white ground, having printed on it rows of letters in a diminishing scale of size from above down. The letters are made of such definite size that the normal eye can read them at distances determined for each line. The card is hung up, and the child stands at a distance of 20 feet, or 6 metres. Above each line of letters will be observed the distance at which that line should be read. Thus above a line of quite small letters is the figure 6. This indicates that this line should be read a distance of 6 metres, or where the child is standing. The vision in this case would be stated to be $\frac{6}{6}$ or 1. But if at 6 metres the child could only read the line above which the figure 12 was printed, it would be marked down that his

vision was $\frac{6}{12}$. Many children with quite good eyes only see $\frac{6}{9}$ in school, and for that reason Dr. Wright Thomson has advocated that this be taken as the standard, and not $\frac{6}{6}$. It must not be forgotten, as already remarked, that for complete vision there is a mental act beyond the physical one involved in focusing light-rays upon the retina. The writer has been struck with the somewhat defective vision, as tested by the card, in young children who appeared to have normal sight, and the explanation is, of course, that the child really did see the letters clearly enough, but did not interpret them correctly. In cases of doubt, the child might be tried with some object held against the card, such as a pencil, key, watch-chain, and so on.

Further, as Dr. Wright Thomson points out, if a child is marked as having vision $\frac{6}{12}$ or $\frac{1}{2}$, it must not be understood that the child has only half the sight of an ordinary child. It merely indicates that he only reads at 6 metres what he should read at 12, and too narrow deductions must not be drawn therefrom.

The following are the directions issued to teachers by the School Board of Glasgow, for the testing of the eyesight of school children; no apology is needed for quoting them at length:—

Do not expose the test-card except when in actual use, so that the letters may not be learned "by heart".

Hang the card in a good light in such a way that the child does not face an outside window when reading it. A good position is on the side wall which has no outside windows, nearly in line with the teacher's desk.

Measure off 20 feet, or 6 metres, across the front of the room and chalk a line.

Direct the class to stand and turn *away* from the test-card.

Let each child come down in turn and toe the line.

Test the eyes separately, covering the eye not in use by holding a stiff card in front of it. *If pressure is made on the eye with the fingers it will not see well when tested.*

By pointing to the letters on the card, find the lowest line in which the majority of the letters can be read.

If the line marked 9 is not read enter the child's name in the form provided, and in the vision column state the number of the lowest line which is read. If no letters can be read enter a figure 0.

If the child has glasses, test with them on.

Carry out the testing in as clear daylight as possible.

In this way a preliminary sifting is made, and it is only an oculist who can tell if a genuine ocular defect exists. That the child may get the benefit of this skilled advice the following card is sent to the parents of the children with defective eyes:—

SCHOOL BOARD OF GLASGOW

.............................*PUBLIC SCHOOL*

Your child's eyesight seems to be defective. You are advised to consult a doctor or to visit a dispensary or infirmary at once.

The child, after being properly examined at an ophthalmic dispensary or eye infirmary, is ordered glasses if these be requisite, and the final duty of the teacher is to *see that the glasses are worn.*

The Ear.—In the matter of teaching, the ear is practically coequal in importance with the eye (fig. 51). The organ of hearing consists of: (1) the external ear or auricle (A), which serves in part to collect sound-waves and direct them down and into the ear proper; (2) the external auditory canal (B), a tube leading downwards and inwards and terminated at its lower end by a thin membrane, the *drum* of the ear (C); (3) the middle ear, traversed by a short chain of three minute bones (E, M), the movements of which transmit the vibrations of the drum to the internal ear; (4) the internal ear, where these vibrations or oscillations produced by external sound-waves are converted into nerve-impulses and transmitted by the

auditory nerve to the brain, there to be interpreted as sound impressions and sensations. From the throat, on each side, there extends a tube to the middle ear. This is called the Eustachian tube (I), and is usually closed, its lower end opening only during the act of swallowing; it exists for the purpose of allowing air to enter the middle ear from time to time.

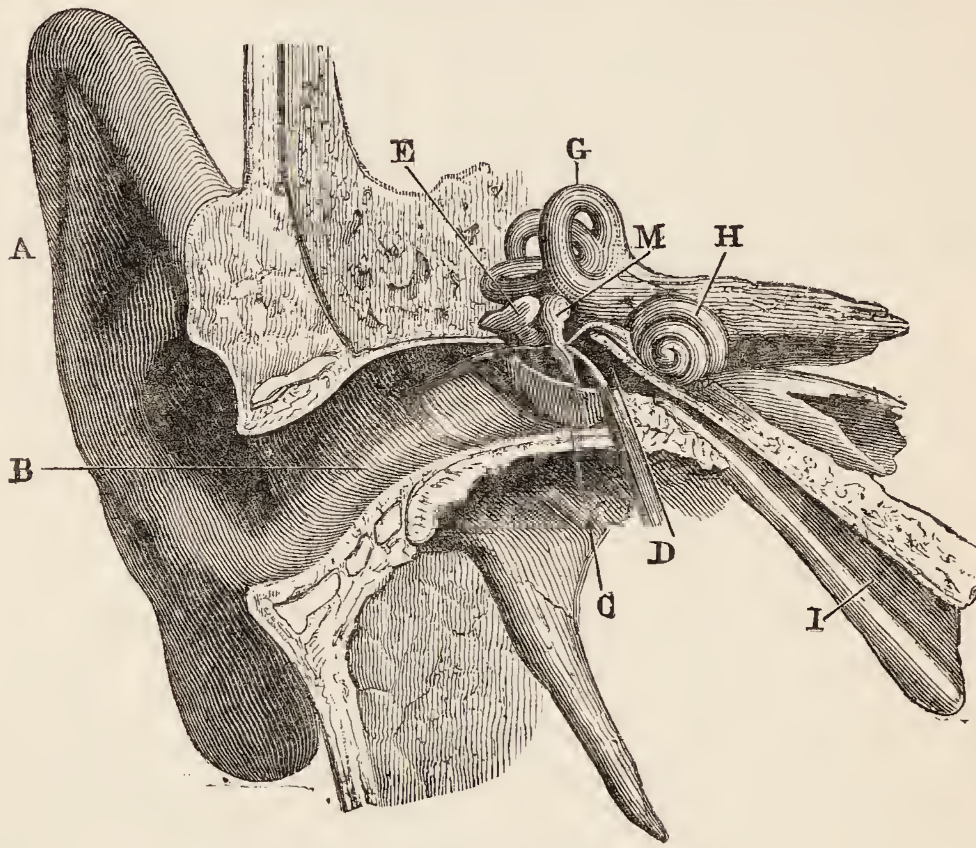


Fig. 51.—The Ear of the Right Side

A, Auricle; B, external meatus; C, drum, partly removed; D, cavity of tympanum; E, incus, and M, malleus—small bones of the middle ear; H, cochlea, and G, semicircular canals of internal ear. [These latter parts are buried in the temporal bone of the head.] I, Eustachian tube passing from the cavity of the middle ear to the throat.

Deafness.—This in a more or less complete form may arise in various ways. It may be found with no apparent disease of the ear proper, as where deafness supervenes on some great emotional excitement, such as grief or joy, or where it follows a disease like mumps. In a large number of cases it is due to accumulations of wax in the outer tube of the ear—a condition easily remediable by syringing with warm water containing a little soda. In not a few cases in children deafness

comes on in one or other ear (not necessarily complete) as a result of a disease like scarlet fever or measles. Infection spreads up the Eustachian tube from the throat, pus or matter forms in the middle ear, and this abscess may open through the drum of the ear, leaving a permanent hole. Deafness may arise from injuries to the ear, secondary to violent blows on the side of the head. Boxing of the ears is a form of chastisement that should be stopped entirely. Not only may the external ear or auricle be bruised and made to swell, with bleeding, perhaps, beneath the skin, but the delicate mechanism of the middle and internal ear may be so greatly jarred that the hearing may be seriously impaired. It is right that teachers should be cautioned on this point. Any chastisement that prejudicially affects a special sense, such as sight or hearing, is one to be left severely alone; for if mischief follow, the instrument of correction may find himself in the unpleasant position of having to defend a civil action for damages. This has already happened.

A teacher soon finds out what children are deaf. A little care must be exercised to discriminate from this real physical affliction and stupidity or inattention. If doubt exist, the child may be asked a few questions, not relating to school-work, in a low tone. In all cases of impaired hearing, the parents should take the child to an ear hospital or dispensary. In cases in which the child hears well with one ear and has a discharge from the other, especially if that discharge have an offensive odour, the teacher should do his best to have the child attended to. The risk here is that inflammation may spread from the middle ear to the brain, from which it is separated by a very thin plate of bone, and set up suppuration in the brain substance, an eventuality which has frequently occurred, not infrequently with a fatal termination.

Acute and Chronic Affections of the Tonsils.—The tonsils are small rounded prominences situated one on each side of the back of the mouth, at the beginning of the throat. They are sufficiently well known to most people, and require no special description. They are very commonly affected in

children, and may not only give rise to a good deal of discomfort and trouble, but, it is now somewhat generally held, may be the starting-point of infectious illnesses, the breach at which germs of disease gain entrance to the system.

A common minor ailment of the tonsils is where they are the seat of small whitish-yellow spots. These may be associated with no acute symptoms, such as fever or great pain, but the subject of them is usually "run down", and perhaps habitually breathes in an ill-ventilated room. A point of much importance here is the question as to whether or not the case is one of mild tonsillar illness or one of genuine diphtheria. It is better in all doubtful cases to regard the case as infectious, to have the children sent home, and notice given to the parent. Even the experienced medical man may be unable to pronounce a definite opinion till a bacteriological examination has been made.

Acute Tonsillitis is a very painful affection, accompanied by fever, great prostration, and difficulty in swallowing. If the greatly inflamed tonsils suppurate, the condition is termed *quinsy* and may end fatally. A child with acute tonsillitis is too ill and weak to go to school. One thing, however, is certain, and of importance in the hygiene of schools. These acutely inflamed throats are probably always infectious, and are due to the invasion of the tonsils by micro-organisms. The writer has often been struck in private practice with the fact that the illness can generally be traced to a stay in a close badly-ventilated hall, some two evenings previously. Theatres, churches, mission-halls, evening class-rooms, any place, in fact, where ventilation is bad, artificial light (gas, at least) employed, and many people massed together, are the great sources of sore throats of this kind. Let this be borne in mind by teachers, and let every opportunity be taken of purifying the air of the class-room, consistent with the reasonable comfort of the inmates.

Chronic Tonsillitis.—Children may not often appear at school with acute inflammation of the tonsils, but they may, and very often do, have chronic enlargement of them. The

tonsils, increased in size and often somewhat red, may be seen projecting into the mouth and encroaching on its cavity. The child generally breathes through the mouth, snores at night, acquires a vacant and stupid expression, and is particularly liable to attacks of sore throat. This condition of enlarged tonsils is very often associated with the presence of *adenoid* growths, which we shall now consider.

Adenoid Growths.—These are masses of gland tissue (Lat. *adenum*, a gland) which spring from the upper and back part of the mouth, opposite the posterior nostrils. When we breathe through the nose alone, air enters by the front or anterior nostrils, passes along the floor of the nose, and enters the upper and back part of the throat by the posterior nostrils (see fig. 5). It is very common among children to have hypertrophy of glandular tissue at this part, and soft, irregular masses project from the walls in this region, and seriously obstruct the posterior nostrils. They were first discovered by Czermak, but received serious attention for the first time at the hands of Wilhelm Meyer of Copenhagen in 1873, as a result of his observations on Danish school-children. They are most common in the early years of age, and indeed are frequently of quite a considerable size by the time a child is three or four. They are very often associated with chronically enlarged tonsils. As the subject of them grows up they tend to shrink, but the effects they have produced persist; education may have been interfered with, and the middle ear may have become affected.

The symptoms of adenoid growths are numerous and striking; they are as follows:—

1. Mouth-breathing, occasioned by the difficulty in drawing air through the posterior nostrils.

2. Peculiar facial expression, resulting in part from the fact that the mouth is usually gaping, which causes the child to look stupid, in part from the fact that the nose tends to be compressed from side to side, and in part from a peculiar veiled look of the eyes from a raising of the lower lids.

3. Deafness, resulting from blocking of the openings of the

Eustachian tubes, and loss of resonance in the voice because the upper part of the throat, which should act as a resonating chamber, is filled up.

4. A bluish tint mingled with the ordinary pink of the cheeks, due to the defective aeration of the blood. The child cannot take in sufficient oxygen for its needs, and part of the blood always remains in a venous state. The blue or purple tint is well seen on the cheeks and lips.

5. There is a strong action on the part of the diaphragm, to enable the child to draw in the air it needs through the narrowed upper air-passages. This action leads to a lateral grooving of the chest-walls, and the chest may become long and narrow, favouring the development of consumption.

6. Headache and inability for mental exertion are not uncommonly observed in those with adenoids.

7. There is a greater liability to infectious diseases than in the case of a child with normal throat.

8. It is possible that the presence of adenoids interferes to some extent with the development of the anterior part of the skull, and thus with those parts of the brain so situated. As the anterior parts of the brain contain almost certainly the greater portion of the intellectual centres, one can see that anything impeding their full growth will tell harmfully against progress in education.

The teacher is generally led to suspect something amiss with the back of the throat when a child breathes regularly with the mouth open, is slightly deaf, has a dull and stolid expression, and presents a slightly bluish tint in the face. A strong recommendation should be conveyed to the parents to have the child treated at hospital or dispensary. These growths, as well as enlarged tonsils, are easily removed by a slight operation, which is usually in all respects successful. No other treatment is of any use.

CHAPTER X

Infectious Diseases in relation to School Life—Their Causation and Mode of Spread—Incubation—Invasion—Advance and Decline—Principal Diseases of Importance—Scarlet Fever—Diphtheria—Measles—German Measles—Whooping-cough—Small-pox—Chicken-pox—Early Symptoms.

Infectious Diseases in School Life.—The ordinary infectious diseases demand careful consideration in reference to the health of children in elementary schools, for they constitute every year a great cause of morbidity and loss of attendance, and from the age, the unprotected state, and the conditions of life of children at school, are spread with great rapidity.

We shall use the term *infectious* while dealing with these diseases, making no distinction between infection and contagion. An infectious disease is one which can be transmitted directly or indirectly from one person to another. Contagion simply means infection by actual contact as opposed to that at a distance. Both imply the existence of some "infective material" or contagion, which, handed from one person to his neighbour, finds in the latter a congenial soil, and increases so as to produce a definite infectious illness. The term *zymotic* (Gr. *zume*, a ferment), so often seen in the newspapers, was introduced by Dr. William Farr in 1842. He used it to embrace generally epidemic, endemic, and contagious diseases. It is now employed in a somewhat more restricted sense to cover certain definite infectious diseases, as indicated by the Registrar-General.

Cause of Infectious Diseases.—In a considerable number of infectious diseases the cause has been definitely discovered, and has been shown to be a minute germ or micro-organism. Some of these are round, some are rod-shaped, others are curved or of a spiral form. They are commonly about $\frac{1}{8000}$th of an inch in length, are seen distinctly only with a microscope of very high magnification, and are capable of reproducing themselves very rapidly in a suitable medium. They produce in many cases poisons of much virulence, which may seriously

affect the nervous system, heart, or other organs, and may even end life itself. The germ or micro-organisms of consumption, typhoid fever, diphtheria, leprosy, and various other diseases is already known; in the case of small-pox, chicken-pox, measles, and certain others it is not yet definitely known, but it is inferred, from the phenomena attendant upon the origin, course, and spread of the disease.

Modes of Spread of Infectious Diseases.—Infection may be spread in the following ways:—

1. *Aerial*, as in the case of whooping-cough and measles, where the contagion is disseminated through the air.

2. *Alimentary*, as in typhoid fever, which may be spread by infected water, milk, or shell-fish.

3. *Corporeal* (*direct*), or through personal contact, as in the case of scarlet fever and small-pox.

4. *Corporeal* (*indirect*), as where cats carry the germs of diphtheria, or flies that of typhoid fever.

5. *Fomital*. This term is applied medically to the conveyance of infections by personal articles, such as clothing, bedding, carpets, and so forth. Small-pox and scarlet fever are readily spread in this way, and the plague in the East.

6. *Telluric*, or spread by means of the soil. This mode is at least suspected in certain transmissible diseases.

The Stages of an Infectious Disease.—An illness of this kind being due to the entrance within the body of a living germ, capable of growth and multiplication, and of the production of poisons, it is reasonable to suppose that the illness will not grow to maturity in a night, like Jonah's gourd, but will pass through certain stages or cycles. This is the case, and a little attention must be devoted to this matter, as a careful study of these phenomena has led to a knowledge of how to lessen the spread of infection.

Incubation.—The period of incubation of an infectious disease is the time that elapses between the entrance of the infection into the system and the date when the earliest symptoms appear. For example, a child comes into contact with a little friend who has scarlet fever. In that hour the

poison enters the system of the healthy child, and four days later the latter is ill with headache, sickness, and feverishness. We say in such a case that the time of incubation has been four days. It is during this period that the infecting germs multiply greatly and begin to form poisons, but during this period the patient-to-be feels nothing, goes to school, plays with his companions, and has apparently nothing the matter with him. The incubation period is not a definitely fixed one for any disease. It ranges between certain limits, keeping as a rule fairly near some definite time. In small-pox, for example, the incubation time is nearly always eleven or twelve days, but in typhoid fever it varies from ten to twenty-one days. Some writers classify these diseases according as their incubation period is long or short, and this does perhaps aid in remembering about them. The following is a table of the commoner infectious diseases, with times of incubation:—

A.—Diseases with Short Incubation Periods

		Limits.		Usual Time.
Diphtheria	......	2 to 7 days	......	2 days.
Scarlet Fever	......	1 to 8 days	......	3 to 4 days.
Influenza	......	1 to 4 days	......	2 days.
Erysipelas	......	3 to 7 days	......	4 to 5 days.

B.—Diseases with Long Incubation Periods

		Limits.		Usual Time.
Typhus Fever	......	7 to 14 days	......	12 days.
Typhoid Fever	......	7 to 21 days	......	About 14 days.
Chicken-pox	......	10 to 15 days	......	About 14 days.
Small-pox	......	9 to 15 days	......	Generally 11 or 12 days.
Measles	......	7 to 18 days	......	Generally 14 days.
German Measles	......	12 to 21 days	......	About 14 days.
Mumps	......	14 to 21 days	......	About 16 days.
Whooping-cough	......	7 to 14 days	......	About 10 days

A knowledge of the incubation time of an infectious disease is important in this respect, that if a child has been exposed to infection and passes the outside limit of the incubation period without showing any symptoms, it is safe to conclude that he is not taking the illness at that time. For example, a

girl develops scarlet fever at home, and is removed to hospital. Her little sister, aged eight, has slept with her the night the fever declared itself. She attends a public school, to which she obviously cannot be allowed to return till there is reasonable assurance that she has not caught the infection. This assurance will have been obtained if the child remain well and free from symptoms for, say, eight days.

Invasion.—This term indicates the time of *sickening*—the period between the first appearance of symptoms and the development of the rash (where such is present), or the full development of the illness where a rash does not appear, as in mumps. As a rule, it is short. In diphtheria, scarlet fever, influenza, erysipelas, chicken-pox, and mumps it is only a case of some twenty-four hours. In German measles it is only two days. In measles and small-pox, sickening lasts three or four days, in typhus fever usually four. Typhoid fever has an invasion time of seven days, and in whooping-cough it is a little indeterminate, something between one and two weeks.

Advance.—This expression is applied to the course of the illness when fully established. It extends, therefore, from the end of invasion till the disease begins to abate.

Termination and Convalescence.—In some infectious illnesses, such as typhus fever, the steady course ends abruptly, the fever suddenly falling and convalescence setting in. This sudden change is called the *crisis.* In many illnesses, however, the decline is more gradual; day by day there is less fever, and more gain of strength, in which case it is said to terminate by *lysis.* Convalescence is the process and stage of return once more to ordinary health. It is very protracted in certain infectious illnesses, notably in influenza and typhoid fever.

These preliminary observations will help us to understand the natural history of infectious illnesses. The seed of it, so to speak, is planted in suitable soil (the body of a susceptible child, for example), takes root there, flourishes and increases, causes ill-health and general harm, and then gradually declines in a case where recovery takes place. In unfavourable cases, sooner or later in its course, the affected person is overwhelmed

by the poison or by some complication which the illness causes, and a fatal issue results.

Protection.—Nearly all infectious diseases confer a certain immunity against a second attack. This accounts, of course, for the great incidence of these diseases in childhood as compared with adult life, for most adults, after all, have had measles, whooping-cough, and certain other infectious ailments. Even apart from previous attacks, adults are not so susceptible to the germs of certain diseases as children are, and so it happens that the latter bear the brunt of such illnesses, both from their unprotectedness and from their greater natural susceptibility. Some children never take a common infectious disease though exposed to it. They are then said to possess a natural *immunity*—some bodily condition which protects them,—and, as mentioned already, a previous attack gives an immunity also,—in this case acquired.

The protection conferred by a previous attack is not equally good in all illnesses. It is, as a rule, very good in small-pox, typhoid fever, chicken-pox, and whooping-cough; in scarlet fever it is also good. Measles and German measles by no means protect; it is not very uncommon to hear of a third attack of measles, while second attacks are fairly common. Diphtheria confers no immunity against a subsequent attack, indeed one would rather say that it rendered the patient more prone, if anything, to a second infection.

Time of Infectiousness.—The common infectious diseases vary with regard to the time at which they are most liable to be transmitted. Some are infectious very early, before a rash appears; in the case of others it is during the height of the illness that the poison is most likely to be handed on. The source of infective material also varies with different diseases, being the secretions of the nose and throat in measles, the motions in typhoid fever, the skin scales and nose secretion in scarlet fever, and so on. One of the most important illnesses in school life with reference to infection is measles, which is very readily spread, and is transmitted during the period of invasion before the rash comes out. It thus becomes

disseminated among the children before its nature is recognized, and is responsible for much illness and loss of attendance. Diphtheria, too, is often spread in its early stages at a time when the primary sufferer is supposed to be merely the subject of a sore throat. Special points with reference to infection will be brought out when dealing in detail with the various different diseases, of which a short account will now be given.

Scarlet Fever.—The disease known as scarlet fever, or scarlatina, is not the commonest of the infectious diseases of school life, but is one of the most important on account of its extreme infectiousness, the long absence it causes, and the risk of life which it entails in the case of young children. *Incubation* is short, being one to eight days, usually three or four. *Invasion* is also short, lasting twenty-four hours. This time of sickening is characterized by a feeling of languor and restlessness, the child being evidently out of sorts. Headache is common, sore throat is complained of, and the skin may feel hot. Not unfrequently there is vomiting. The child does not care for food, but may be thirsty. The symptoms are generally present, more or less, in this initial period of scarlet fever, but they do not enable a teacher (or even a doctor) to say what the illness really is. After this short stage the *rash* comes out. It spreads over the body from above down, showing earliest on the face and neck. It quickly comes out, as a rule, and is very easily seen on the front of the forearms and the upper part of the chest, rapidly assuming a distinct uniform redness. In some cases it is very intense, meriting the term "boiled lobster" appearance. It is not raised above the surface, and goes momentarily if the skin be pressed on by the finger-tip. The throat is red and often swollen, especially in the region of the tonsils, and the child is highly feverish. Any red rash on the arms or chest of a child should arouse suspicion in a teacher's mind, and it is best to regard such a case as a possible one of scarlet fever. In a genuine case, after a few days, the rash fades away, and *desquamation* or peeling sets in, first about the neck, as fine branny scales, but spreading all over the body. These scales or flakes of skin are very infectious, especially

during the early time of peeling. Recent observations support the view that the skin scales are not very infective towards the end of the stage of desquamation, but it is right in general to consider every case while peeling as dangerous.

It occasionally happens that the initial symptoms are so slight and the rash so evanescent that scarlet fever is not suspected. Peeling follows, however, and the first indication that there has been anything wrong is found in this. On investigation it is discovered that the child, some few weeks previously, suffered from sore throat, and that perhaps there was a similar case in the same house, or a genuine one of scarlet fever. These cases are very dangerous, as, being unrecognized, they may spread much infection in a school. Any child with peeling of the skin, however slight, should be regarded with suspicion, in the same way as one with a red rash. The occurrence of sore throat in the case of either makes one still more certain.

Scarlet fever is infectious at the very beginning, probably before the rash is out, the infective material being at this time chiefly in the throat. It can thus be spread by coughing. In the time of advance it is extremely infectious by means of the skin scales, and at the end of peeling may still be conveyed by the secretions of the nose. Peeling lasts usually for six weeks, sometimes longer, the most troublesome parts to peel completely being the hands and feet. The infective material is very persistent, and may cling to garments for many weeks.

A child who has had scarlet fever can only return to school after complete peeling, after discharge from the nose and ears has ceased, and preferably after it has had a change of air for a week or ten days after apparently being free of infection. This illness, therefore, generally takes a child away from school for eight weeks. If a child has been exposed to infection, one cannot feel certain that the illness will not be contracted till eight or ten days have elapsed. Let it be borne in mind that mild cases may escape detection at the time, and only be discovered by the existence of peeling. It is always a serious illness for young children. One attack usually protects against a subsequent one.

Diphtheria.—This illness is to be dreaded on account of the ease with which it can be transmitted, and the somewhat high mortality still attendant upon it, in spite of modern treatment. It is due to a definite and well-known bacillus (named the Klebs-Loeffer, after its discoverers), and the seat of attack is the throat, nose, or windpipe. Incubation is short, two days usually sufficing, though it may be as long as seven. Invasion is very rapid, the affection of the throat manifesting itself in a day. There is no external rash. Some cases are very mild throughout, and do not prevent the child from going about and attending school. These cases are supposed to be instances of mild sore throat, but they are really infectious, and may give the disease in a more severe form to other children. In severe cases the child soon becomes very ill and prostrate, and of course is kept from school.

In the ordinary case, the invasion period begins with headache, languor, and perhaps pains in the limbs, much as a common cold does. Soreness or stiffness in throat is complained of, and the skin may feel hot and dry. If under such circumstances a teacher examine the throat, it will appear red and congested, especially about the tonsils, and there may be a little swelling. Let a word of caution be given here with reference to the examination of the throat, a procedure which must often devolve on the teacher.

How to Examine the Throat.—We shall presume that suspicion has been aroused that the case may be one of infectious disease, say scarlet fever or diphtheria. Let the teacher place the child facing a good window-light, and stand himself with the back to the light, and almost, but not quite, opposite the child. The child is then asked to open the mouth as widely as possible, bending back the head to such extent as will let the light enter freely. A good view of the tonsils and back of the throat may now be obtained, but in many cases the soft palate (with its little central tongue, or *uvula*) hangs low and occludes the back of the throat. The teacher should then (and indeed in every case) ask the child to say, or rather intone, "ah" loudly and clearly, on a fairly high note, sustain-

ing the latter as long as possible. When this is done it will be seen that this act (phonation) causes the soft palate to rise like a curtain from the back of the tongue, and a much better view may be obtained. Obstruction may still persist, however, in the shape of the tongue, which often seems to arch itself up in a very peculiar way, completely hiding the back part of the mouth. Two plans are available for removing this difficulty. One, which should always be tried first, is to get the child to draw the tongue forwards and downwards himself. To accomplish this, let the teacher cut a strip of white blotting-paper, about 2 inches by 1, and fold it across. This is given to the child, who protrudes his tongue as far as possible, and, placing it inside the folded blotting-paper, draws it forwards and downwards by grasping the latter. The paper being porous absorbs moisture from the tongue and adheres slightly to it, preventing it from slipping. The child's hand does not touch the tongue directly at all. This stretching of the tongue flattens it, and so enables one to get a much clearer view of the back of the throat. When this has been done, the paper can be placed inside a second folded piece of somewhat larger size, and the whole burned. This is much better than asking the child to pull forward the tongue by his fingers or pocket-handkerchief, especially in suspected infectious disease. If this plan does not prove satisfactory, it is necessary for the teacher to depress the back of the tongue by some appropriate means. At home this is frequently done by means of the handle of a tea-spoon, which can, of course, be disinfected (or rather sterilized) by dropping it in a little boiling water after use. This is not suitable for school, however, and the best plan is to use a small strip of plain wood, which the teacher holds at one end by means of the right hand, steadying or moving the child's head with the left. The back of the tongue is gently but firmly depressed, and the child at the same time asked to sing "ah". Care must be taken not to put the depressor of the tongue too far back, else the child will cough or splutter. At the very first suggestion of this, the observer should quickly withdraw the stick, or whatever is

used, and rapidly turn his head aside, in case any coughed-out particles touch his face. This is most important in cases of suspected diphtheria or scarlet fever, where such particles may be very infectious.

To return to our consideration of diphtheria. The throat in an early stage may appear simply red and a little swollen. The typical feature of diphtheria, which quickly shows itself, is a greyish or yellow or whitish patch of membrane, or *exudation*, lying on one or both tonsils, the soft palate, or the back of the throat. No definite statement can be made as to the extent of the membrane. Occasionally it presents the appearance of simply a whitish spot on a tonsil; in other cases it is of considerable extent. The throat may feel swollen outside too. The tongue often appears furred. It is a safe rule for general guidance that any child with spots or patches on any part of the throat should be regarded with suspicion and recommended for medical supervision. Unrecognized diphtheria is a serious matter, on account of the high infectiousness of the disease.

In mild cases the child may appear quite well at the expiry of one week, and the throat may look normal; in severe cases the child is ill for weeks, it may be. Infectiousness dates from the very beginning, the bacilli which cause the disease lying abundantly in the patches on the throat and in the secretion of the nose, where they produce in their life-growth poisons of great virulence. It is easy to see how, by coughing or spitting, a child with diphtheria could give the disease to its neighbour. As regards the time of suspense after a child has been in contact with a case, as the extreme limit of incubation is seven days, we may say that the child is free from risk after the lapse of a full week. Diphtheria, as a rule, incubates quickly.

The time of infectiousness varies greatly. No definite time can be set down, but it may be said that as long as the bacilli of the disease lurk about the throat, the patient is a menace to others. The fact that the throat looks well does not prove that it is free from the germs, for after an attack, and when

the patient seems quite well, the throat may still hold the cause of the disease. This point can only be determined by bacteriological examination of mucus from the throat; and as practically all cases of diphtheria (recognized) among elementary school-children are treated in hospital, the necessary examinations are made there, and the child is not allowed to leave till the throat is clean.

Measles.—This is the infectious disease *par excellence* of elementary school life. Extremely infectious, and readily spread before its nature is recognized, it is a cause of much sickness, of great loss of attendance, and may attain such epidemic characters as to necessitate the closure of the school. It is not in itself a disease of great severity; but it is associated so often with whooping-cough and bronchitis, and followed so frequently by a form of inflammation of the lungs in children (which may terminate in consumption), that it becomes in the long run a considerable menace to life itself. Only too commonly is this the story among children of the working-classes: a little girl, let us say, of six or seven has measles in December, gets well apparently, and is in February the subject of whooping-cough. Bronchitis develops as a complication of the latter, but seems to subside after a time, leaving, however, persistent cough and a constant feeling of poor health. The child grows thin and pale, gets fevered at night, begins to cough up matter from the chest, and is then found to be irreparably the victim of consumption.

Measles takes from seven to eighteen days for *incubation*, usually fourteen. The *invasion* time is one of great importance, as the disease is fully infectious at this time, which lasts three or four days. The symptoms during this time are well known, and are of the nature of a "cold in the head", but with less secretion perhaps. The eyes look red and irritable, and the throat and nose are congested. The eyes tend to water, the nose to run, and there is a hard cough, harsh in character, with little to cough up. There is headache, a feeling of tiredness, and sometimes sickness or vomiting. All these symptoms, however, may be slight, and in many cases all that either the

parent or teacher notices is that a child has a cold in the head.

After a period of three or four days of sickening, the *rash* comes out. It is usually seen first on the face, particularly on the forehead, at the roots of the hair, behind the ears, on the cheeks, and on the neck. It quickly spreads over the body. A well-developed measles rash is one of the easiest to recognize: there are, at first, little red spots, and these quickly amalgamate to form blotches of a reddish colour, and having a shape that is roughly crescentic. The rash is darker than in scarlet fever—more of a reddish-purple than scarlet. The face looks swollen and congested, and this swelling, along with the irritation of the eyes, gives what is called a "ferrety" expression. The rash fades after five or six days, and there is often a little fine scaly peeling of the skin. As a rule, a child feels quite well in a fortnight, in an ordinary case, but return to school should not be allowed till three weeks have elapsed. The infection is greatest during invasion, and after a fortnight little is to be feared. Schools are frequently closed on account of measles, but by the time the epidemic has become so serious as to require this step the mischief has usually been done, and if there are many ill there are also many sickening, and these are infecting their playmates freely out-of-doors.

Measles is particularly one of those diseases which ought to be arrested before it assumes epidemic proportions. Whenever there have been one or two cases, the teacher should be alert and on the watch for all children showing signs of languor and cold in the head. These should be (preferably) kept at home for four or five days; if this is not feasible, these suspects should be seated apart from the other children. Never regard measles as a trifling illness. Whooping-cough and it are the two most fatal zymotic diseases of the British Isles after epidemic diarrhœa, demanding yearly, through its complications and contingencies, a heavy toll of young lives.

German Measles.—This illness is a very mild affection, known also by the name of *Epidemic Roseola* or *Rubella.* It usually occurs in epidemic form. After an *incubation* of a

fortnight, on an average, the disease appears with some suddenness, there being little in the way of preliminary symptoms, that is to say, little invasion period. An eruption comes out all over the body, resembling that of measles more than that of scarlet fever, and consisting of tiny red spots. The rash is not such a uniform red as in scarlet fever, nor so blotchy as in measles. The child may appear perfectly well, and have no fever. The throat is sometimes a little red and swollen, and there may be some enlarged glands well back on the side of the neck and extending up to the roots of the hair behind.

This disease is probably infectious as soon as it shows itself by its rash. The child who has it should be kept from school for two and a half or three weeks. It cannot be expected that a teacher should diagnose the disease if a child is perchance seen with the eruption out. The case should be regarded as one of probable infectious disease, be it measles, scarlet fever, or other complaint, and should be dealt with as such.

Fourth Disease.—A fourth affection, differing somewhat from scarlet fever, measles, and German measles, has been described by Dr. Clement Duke, medical officer to Rugby School. In his book, *Health at School* (4th edition, 1905), he describes it as a mild eruptive disease, with a rash like that of scarlatina, and a rather long incubation time, reaching sometimes twenty-one days. The health is very little disturbed, the complaint does not become epidemic, and it is most common in spring. It is merely mentioned here for the sake of completeness; any school-child with a rash should be kept from school and watched.

Whooping-cough.—Attention has been already drawn to the frequent association of measles with whooping-cough, and it is a combination to be dreaded, especially in weakly, ill-nourished children. One or the other, or both, are responsible for an immense amount of poor health among children of the working-classes, and, unfortunately, for a very large number of deaths too. Taken with its complications it ranks third, according to Dolan, among the most fatal diseases of children in England. It occurs chiefly in winter and spring, and through

its long period of infectivity is responsible for much absence from school.

The precise cause of whooping-cough has not yet been discovered, any more than that of measles, but it is certainly a germ, easily conveyed from one child to another, particularly by coughing and sneezing. The *incubation* time averages ten days. A child who has been in contact with a case of the illness begins, after the lapse of this time, to suffer from what appears to be an ordinary cold, with cough and some expectoration, or spitting out, of phlegm. This is the first stage of whooping-cough, sometimes termed the *catarrhal*, as it is characterized by catarrh of the breathing passages. This "cold", however, in spite of ordinary care, does not seem to get much better, and after the lapse of a fortnight the observant parent or teacher notices that the cough which has been present throughout is occurring in short, sharp paroxysms. At various times through the day the child will be seized with short, sharp attacks of coughing of a hard character, and if enquiry be made it will be found that these paroxysms are still more troublesome by night. The child has now entered on the second or *paroxysmal* stage of the illness. In a typical case, when the attack comes on in this second stage the child feels and looks distressed, may grasp a table, desk, or other solid object to steady itself, and then gives vent to a series of short, sharp, expiratory coughs or barks, followed by a long-drawn noisy inspiration, the "whoop", or as it is termed among the working-classes of Scotland, the "kink". This is repeated several times, and the whole seizure may end in vomiting.

This second or convulsive stage drags out a weary length of days. The writer has known instances where it went on, in a more or less modified form, for six months. As a rule, after six or eight weeks it gradually lessens, and the patient enters on the third stage of the illness, that of *decline*, ending, in favourable cases, in recovery. Even though the child get quite well, the severe strain of coughing may affect the shape of the chest, producing the "pigeon-breast" already referred to (Chapter VIII). One attack usually protects for the rest of life.

There is often considerable difficulty in knowing whether the child really has whooping-cough or not. In mild cases the typical cough with its series of short barks and long indrawn breath is absent, and yet these cases are infectious. It is a safe working rule to assume that if a child has a persistent paroxysmal cough lasting many weeks, while other cases of the disease are prevalent, the illness is really whooping-cough. There is no rash, no other symptom that makes one quite sure. The unfortunate thing is that the mothers cannot be got to regard whooping-cough as anything but a trifling illness, and even if the child is kept from school, he or she is allowed to go out, play in a back-yard, mix with other children, and frequently run the risk of getting bronchitis or pneumonia.

Whooping-cough is chiefly infectious during the paroxysmal stage, the infective material lying in the mucus of the air-passages. It is generally spread by direct corporal contagion, rarely through the intermediary of a third person or by clothing, though this is possible. It is impossible to say precisely how long infection lasts; it certainly does not persist throughout all the time a child may cough, for that may continue for months. The writer usually regards a child as capable of transmitting the disease for about ten weeks after it has declared itself. It is a sound rule not to permit the return of a case to school under eight or ten weeks from the beginning of the second stage.

Small-pox.—This serious and dreaded disease is fortunately an occurrence of comparative rarity now, thanks to the beneficent protection afforded by vaccination. From time to time, however, it appears in our large cities, and assumes epidemic dimensions, two such visitations having occurred in Glasgow within the last six years.

Incubation is fairly long, being nearly always eleven or twelve days. During this time no symptoms are felt, but *invasion* (which lasts three or four days) may set in quite suddenly. The chief symptoms during sickening are severe headache, great pain in the back, and often attacks of sickness or vomiting. In young children there may be convulsions.

There is feverishness, loss of appetite, and all the symptoms of some impending illness. It is said that in no eruptive fever is the pain in the back and limbs so severe as in invading small-pox.

The rash appears on the third or fourth day, and is first seen on the forehead near the roots of the hair, and on the wrists, as small red spots. These red "papules" increase in size, and become more prominent, and also spread over the face and body. They have a so-called "shotty" hardness when pressed by the finger, as if a pellet of small shot lay under the skin. These spots now show the presence of fluid inside them, and become like little blebs (vesicles), being at this stage liable to be mistaken for the eruption of chicken-pox. These little vesicles show a slight dimpling in the centre. They next become filled with matter, and are termed pustules. This takes about a week to accomplish, and if the case is going on well, the pustules dry up and eventually fall off as dried scabs or scales.

Small-pox is extremely infectious. It can be transmitted by the secretions and exhalations of the skin and throat, and, above all, by the dried-up pustules as they fall off. It is probably infectious as soon as the rash is out; certain proof is awanting that it can be passed on before that. A healthy person can carry it from the sick to another individual, and the poison clings readily to clothing, bedding, and the like. In ordinary cases most of the scabs have dropped off after two weeks, but, as a rule, seclusion of the patient for a period of six weeks is necessary. One attack usually protects.

It is a rare thing, but not an unknown one, for small-pox to show itself in a school, unless there have been other cases in the neighbourhood. When small-pox is known to be about, any child should be regarded with suspicion who complains of severe headache or backache, and should be sent home, while attention on the part of the sanitary authorities is directed to the case. If a child is found with any kind of rash out, under the above circumstances, it would be safer to detain the child at school, in some small room that could be disinfected after,

and request the sanitary inspector or medical officer to see the case there. In epidemics there are always some cases that escape detection at first, and prove a great source of danger to others. The writer well remembers a case of small-pox in a servant-maid, which he saw in the large Glasgow epidemic in 1900. This servant was going about her duties in a small hotel (!), with the eruption already assuming the pustular stage, yet, strange to say, no one else in the house developed the disease, almost certainly because they were all vaccinated forthwith.

Vaccination.—It is only right that a few words should be added here regarding the benefits of vaccination, which, in spite of all opposition, is still regarded (and ever will be), in every civilized country of the world, as one of the greatest boons conferred on suffering humanity. It is the children who have the greatest reason to be grateful, for small-pox is a terrible scourge among the non-vaccinated young. M'Vail collected and analysed the statistics for Kilmarnock for thirty-six years (1728–64), and found that 622 deaths from small-pox occurred during this time, of which 563, or 90 per cent, were below five years, while 98 per cent were under ten. The mortality now, under five, is practically confined to the non-vaccinated. Among the vaccinated the chief mortality falls in the age period thirteen to twenty, because the protection is beginning to fail. From the Sheffield cases of 1887–88, Barry came to the conclusion that *under ten years* the vaccinated as compared with the unvaccinated enjoyed a 20-fold immunity to attack, and a 480-fold immunity to death, while *at all ages* they had a 6-fold immunity to attack, and a 64-fold immunity to death as compared with their unvaccinated neighbours.

It has been said that protection of vaccination (of which such striking proofs have just been adduced) dies out in course of time. Hence arises the need for revaccination, done always on a large scale during epidemics, but not made compulsory in Great Britain. It is obligatory in Germany, and has been attended with very gratifying results. Every child must be

vaccinated within the calendar year following its birth, and revaccinated by the time it attains twelve years of age. The results of this regulation are very striking. In the twelve years 1891–1902 there were in Germany 607 deaths from small-pox in a population of 56,000,000. In England during the same period there were 6761 deaths among 32,000,000! If the rate per million in England had been the same as in Germany, there would have been only 350 deaths in the former during the twelve years. Speaking generally, the death-rate in small-pox among unvaccinated at all ages is 35 per cent of those attacked; among the vaccinated it is 5 per cent.

These facts bring home to one the value of vaccination in diminishing the liability to attacks of small-pox, and to death when attacked, and the special protection it affords to the young. They also clearly indicate the value of revaccination, and in all instances where small-pox becomes rife, the influence and example of school teachers should be enlisted to encourage revaccination among those under their charge. Any objection to the procedure based on the risks of conveying consumption or other disease from one child to another, is once and for all refuted when vaccination is performed with fresh calf-lymph preserved with glycerine, and when strict cleanliness is observed during the little operation.

Chicken-pox.—This illness is almost always a very mild one, and is of importance chiefly because it keeps the affected child from school for a considerable time. The precise cause is not known yet, no micro-organism having been discovered. The *incubation* is ten to fifteen days, most frequently about a fortnight. *Invasion* is rapid, lasting only twenty-four hours, as in scarlet fever. At this time the child is feverish, irritable, and obviously not well. There may be some headache, and, occasionally, some sore throat. There are no characteristic symptoms, however, at this stage. At the end of this time the rash appears, usually on the front or back of the chest first, or on the scalp. It is usually scanty on the face. It at first appears as little red spots (papules), something like those

seen early in small-pox, though they do not become so hard or "shotty" to feel, as in the latter illness. In chicken-pox the red spots show, within a few hours, a little collection of fluid, clear, or at times turbid. The spot thus assumes the form of a rather flat, small blister, with a pink rim encircling it. This bleb-like appearance has led to the disease being called the "crystal-pox" among working-class people in Scotland. At the end of about two days the watery contents of the pocks become purulent (changed into matter), and then they dry up, preparatory to falling off. The spots come out in crops for the first three or four days, and are usually scanty on the face. They leave no mark if allowed to dry up and fall off naturally. If scratched and broken, they heal leaving a little pit. The illness is infectious till all the dried vesicles have separated, and this may require three weeks for its completion.

Chicken-pox is chiefly communicated directly from one child to another. One attack generally protects. It becomes of importance during epidemics of small-pox, on account of the resemblance of the two rashes. A teacher should have no difficulty in deciding what to do. The child must be examined medically, in order that the precise nature of the illness may be ascertained.

CHAPTER XI

Infectious Diseases (continued)—Mumps—Typhus Fever—Typhoid Fever—Erysipelas—Ophthalmia—The Duty of the Teacher when Infectious Disease is suspected—Quarantine—Period of safe return after an Attack—The Animal Parasites of the Skin—The Louse—The Flea—The Itch-insect—Vegetable Parasites—Favus—Ringworm—Medical Inspection of School-children.

Mumps.—This infectious illness sometimes occurs as an epidemic in schools, for it is distinctly contagious, being easily spread from one child to another. It is an inflammation of one of the glands that secrete saliva, the gland affected being the one lying just below and a little in front of the tip of the

lobe of the ear, at the back part of the cheek. This gland is called the *parotid*, and so the disease is sometimes named *Epidemic Parotitis*. It is most common in childhood and youth. The precise cause is as yet unknown.

After a somewhat prolonged incubation period of from fourteen to twenty-one days, the child becomes a little feverish and complains of soreness of the lower jaw, especially at the back of the cheek. The *invasion* is quite brief, for by the end of a day of this preliminary complaint, swelling is noticed below the ear, reaching backwards, downwards, and on to the cheek, so that the side of the face presents a uniform rather tense swelling. First one side is affected, and the other follows suit quickly. The greatest annoyance and discomfort is felt when the patient tries to eat. The pain is not generally severe. There may be a little difficulty in speaking. After a week or ten days the swelling subsides, and the victim soon feels quite well again. The breath is very infectious during the height of the attack. A child is not well for three weeks, or fit to mix with its playmates with safety to the latter.

Typhus Fever. — This serious disease is now becoming almost extinct, thanks solely to ordinary sanitary measures regarding ventilation, admission of sunlight, and general cleanliness. It is specially associated with dirt, privation, and crowding, and in past ages was a veritable scourge in camps and jails, from which it received its synonyms of camp- and jail-fever. It has always maintained a foothold in Ireland among the poorest and most destitute of the inhabitants. As an indication of its rapid disappearance it may be stated that in England in 1875 no fewer than 1500 persons died of it, while in 1895 only 58 succumbed. In 1904 Ireland had 50 deaths from typhus in its population of 4,400,000. Its cause is unknown.

Its rarity saves us from spending much space over its description. The *incubation* is usually twelve days, and *invasion* lasts for four, the symptoms then being those of severe stupefying headache, fever, sickness, aching in the back and limbs, and great prostration. The rash appears first on the chest

and belly, particularly over the front of the shoulders, and spreads over all the body, including the face. It is of a dull mottled red, and is sometimes termed a "mulberry" rash. The illness lasts with much severity for ten days, and then in a favourable case the fever ends by a *crisis*, the temperature dropping suddenly. One attack usually protects.

The disease is said to occur most frequently between the ages of ten and fifteen (Howford), although the mortality is least then. Spears has drawn attention to the fact that the symptoms are often very mild in children, and may be overlooked. As a rule, any child or adult in the invasion period of typhus is much too ill to attend to school, business, or anything else.

Typhus fever is extremely contagious, indeed some regard it as the most easily transmitted of all eruptive fevers. The poison is exhaled from the skin, throat, &c., and may apparently be breathed in. Happily modern sanitation and improved conditions of life have almost banished this terrible disease from Great Britain.[1]

Typhoid Fever.—This illness, also known as *Enteric Fever*, is one fairly common all over the world, and unfortunately still claims many victims yearly. It is not, however, a disease of childhood, like measles and whooping-cough (occurring mainly between the ages of fifteen and twenty-five years), and thus is not of very great importance in school life. It is due to a well-known germ or bacillus, which is the real cause of the disease, and is swallowed in infected milk, water, shell-fish, ice-cream, and the like. One attack usually protects.

Incubation lasts for a fortnight, as a rule, and is followed by a week of sickening, during which the symptoms are very vague, being mainly headache, indigestion, and sickness, and not infrequently diarrhœa. At the end of seven days the patient is really ill, and a rash may be found consisting of small rose-coloured spots, often quite scanty, on the lower part

[1] An old name for typhus was "spotted fever". This name is now used (somewhat loosely) for epidemic cerebro-spinal meningitis, a form of infective inflammation of the brain and spinal cord. A sharp epidemic of this illness visited the West of Scotland in 1906–7. Children are often attacked, and it is very fatal.

of the chest and upper part of the abdomen or belly. Sometimes no rash appears. There are many other signs of typhoid fever with which we have nothing to do here. The writer has had several cases in children, and the patients quickly became so ill that they could neither attend school nor do anything else. The disease is not conveyed from the sick to the healthy by personal contact alone, as in the case of small-pox, scarlet fever, measles, and so on. The infecting material in typhoid lies in the motions of the bowels, where the bacilli are found in large numbers, and as this is obviously not a mode of conveyance likely to come into evidence in school life, it follows that an infected child will rarely give the disease to a companion. Typhoid is really chiefly spread by water- or milk-supplies becoming infected accidentally or knowingly from a pre-existing case of the disease. The illness entails protracted absence from school on account of the weakness it produces.

Erysipelas.—This affection is occasionally met with among children, though it is commoner among adults. It is an acute infectious inflammation of the skin, especially associated with a previous wound or scratch, followed by exposure to dirt. Its cause is a clearly recognized germ, capable of causing blood-poisoning. One attack does not protect, but rather renders the person liable to a second or third.

The *incubation* of the disease lasts three to seven days. *Invasion* is rapid, the patient feeling chilly and shivering, and showing in a few hours a reddish blush on the skin at the infected part. The skin is smooth and tense, looks red, and feels hot. It may presently show small blebs or blisters. There is a feeling of tightness of the skin, and there may be burning pain. It is distinctly contagious, but is not very virulent, and direct contact is practically needed. Any child feeling indisposed, and showing redness on the face or limbs in connection with a scratch, should be regarded as a possible case of erysipelas, or "rose" as the illness is sometimes called popularly.

Ophthalmia.—The occurrence of sore eyes among school-

children is not infrequently a source of much annoyance in schools, and may be a matter of some seriousness to the child itself. This inflammation of the eyes, associated with red, inflamed lids, watering of the eyes, and discharge of matter, is termed *ophthalmia*, and is easily given by one child to another whenever it is attended by discharge of matter or pus.

Simple Ophthalmia is that form of inflammation of the lining of the eyelids and front of the eyeball which is caused by cold or by some chemical or mechanical irritant, such as pepper, mustard, sand, or metallic particles. The eyelids are inflamed and red, the front of the eyeball bloodshot, and there is tenderness and inability to stand the light. The flow of tears is free, and the discharge from the lids is chiefly mucus. The condition usually subsides on the removal of the cause. The advice which a teacher may safely give in such a case (after ascertaining as far as possible that the cause is removed), is that the eye should be bathed with cold water (containing a little borax, if available), or with cold strong tea. A simple shade made of stout brown paper cut to the form of a crescent may be worn, but on no account should poulticing or the application of wet compresses to the eye be suggested. Such dressings simply keep back fluid which should be encouraged to come away, and render the eye more tender and inflamed.

Purulent or Contagious Ophthalmia.—Unfortunately this simple or catarrhal inflammation may, through the entrance of germs into the eye, become purulent, *i.e.*, the watery discharge may become pus or matter. In some cases the condition is purulent almost from the very first. The eye is in a worse state now, the lids being much swollen, their inner surface dotted with little opaque bodies in many cases ("sago-grains"), while the eyelashes are largely wanting. Yellow crusts of hardened matter adhere to the edges of the lids, and cause gluing together of them during sleep. There is risk that ulceration of the front of the eyeball may occur. This purulent ophthalmia is associated with the presence of many micro-organisms or germs, and is highly infectious, being capable of communication by hands, towels, pocket-handker-

chiefs, and similar means. A child with one eye affected will easily infect the other by means of its own fingers.

This form of inflammation of the eyes is much favoured by bad insanitary conditions and by a lowered state of the system. It occurs, therefore, where the poor and badly nourished are crowded together, as in badly-conducted jails, schools, reformatories, and the like. Children living in crowded slum districts are liable to it, and it is easily conveyed to others. Its cure is often tedious, and children in the worst (and most infectious) stage should be kept from school. Recommendation to an eye hospital should be given, and when the condition is improving, and the child is attending school, the teacher should encourage perseverance in lines of treatment that have been laid down. Cleanliness of the hands and avoidance of rubbing the eyes do much to stop its spread or continuance. Children should not be permitted to exchange handkerchiefs at school, and if a child has any inflammation of the eyes, however mild, he or she should not use the ordinary roller-towels in the lavatories. In such a case a separate towel can be arranged for, a teacher for a few minutes supervising the ablutions of the suspected case, and then seeing that the towel was put out of reach of other children. The only permissible kind of active treatment is the use of some mild antiseptic lotion unfavourable to germ life, such as weak Condy's fluid.

The Duty of the Teacher in reference to Infectious Disease.—A teacher owes a duty both to the infected child and to the other children in the class or school. The child who is already ill must be thought of, for, as already remarked, some illnesses apparently mild, such as measles and whooping-cough, may be attended by grave complications or followed by serious consequences; for the child's own sake, then, its case requires attention. Still more necessary is it that the other children should be safeguarded from infection from the one case, for a mild attack in one child may give rise to an epidemic of severe character among unprotected children.

The first thing to do, if the teacher's suspicions be aroused, is to separate the child in the class-room from the other

scholars, and to communicate the suspicions, at the earliest moment convenient, to the headmaster. The child is seen by him, or it may be by the head of the Infant department (if a member of that), and the best course to adopt is to send the child home at once with a note to the mother, in which it may be stated that a rash is present, and that the child must not return to school till it is gone. To this more formal announcement may be added a word of friendly advice with reference to the need of getting medical aid. This procedure would be productive of little good in the case of some parents, and accordingly notification should be sent separately to the sanitary department or to the medical officer of health. In Glasgow the headmaster of each school is supplied with printed forms with counterfoils for this purpose. At the top is written the name of the school from which the notice comes, while the body of the form contains the following words:—

I am led to believe that Infectious Disease exists in the Dwelling-House of the person undermentioned.

........................*Head Teacher*

Date...........

Householder.	Address.	Supposed Disease.

The counterfoil bears the chief data, viz. date, school, name of parent, address, disease. It is not necessary that an exact diagnosis be made by the teacher, and no one should be ashamed if the wrong illness is marked in. Better to call small-pox measles than to take no notice of it. All the teacher has to do is to write in "suspected scarlet fever" or whatever it may be.

Quarantine.—This is the enforced isolation of a child who

has been in contact with a case of infectious disease, or, at all events in school life, the prohibition from attendance till it is certain the disease is not going to develop. As it is only after incubation that symptoms show themselves, it is clear that if in any disease we keep a "contact" case, as it is termed, apart for a time, equal to the longest incubation time *plus* two or three days, we shall certainly know if infection has been acquired, and if the child remain well during this period our minds may be at rest.

On page 157 are given the incubation periods of the most important diseases. It is not necessary to repeat the list here, but the proper quarantine time of any one of them may be found by taking the outside limit of incubation and adding a couple of days. Indeed in certain cases this makes quarantine really too long, as for example in scarlet fever, where infection scarcely ever fails to develop within six days, whereas quarantine would have to be ten. It is better, however, to err on the safe side, and rather insist on a child being kept from school three or four days longer, than run the risk of several children taking an illness that will keep each away for seven or eight weeks. That is the proper way to view the question of long quarantine.

Period of safe return to School after an Attack.—For precisely the same reason we must know when a child may safely return to school after being the subject of infectious disease. We obviously do not want a diphtheria case to return in a fortnight and, by infecting his neighbours, to send four more off for perhaps a month. The following table will be found to afford safe guidance:—

Disease.	Period of Return.
Diphtheria	Not earlier than one week after the throat has been declared free of the diphtheria bacillus by a competent person. This is rarely less than four weeks.
Scarlet Fever	One week after the last particle of skin has been shed.
Influenza............	One week after the child feels well.
Erysipelas...........	One week after the skin appears perfectly healthy.
Typhus Fever......	When health is completely restored.
Typhoid Fever.....	When health is completely restored.

Disease.	Period of Return.
Chicken-pox........	Eight days after the last crust has completely fallen from the body.
Small-pox..........	Ten days after the last dried crust has completely separated from the body.
Measles..............	Three weeks after the rash appears.
German Measles...	At same period.
Mumps	Eight days after the swollen glands have regained their usual size.
Whooping-cough...	Eight to ten weeks from the time of onset of the paroxysmal cough.

In the last-mentioned illness it is useless to wait for the complete cessation of spasmodic cough before the child returns to school, as such cough may persist for months. It is sufficient to wait for ten weeks, when the chances of infection are extremely slight.

Seasonal Incidence of Infectious Fevers.—Before leaving the subject of febrile infectious diseases, it may be of interest to indicate the times of the year in which the most important ones prevail. Apart altogether from epidemics, each disease has its maximum time of prevalence (and also its minimum), and these vary in different countries. In England, for example, scarlet fever has its maximum in October and its minimum in March, while in New York the same disease attains its greatest prevalence in April, and falls to its lowest level in September. Contrary to the expectation of many people, infectious diseases, in Great Britain at least, attain the maximum most frequently in winter. This is probably due to the fact that segregation in close and warm rooms is more frequent then, increasing the chances of infection. The following indicates when the teacher in Great Britain may expect to find most cases of any disease occurring:—

Illness.	Maximum.
Scarlet Fever	October.
Diphtheria	November.
Typhoid Fever	November.
Measles	December, and in June.
Small-pox	February and May.
Whooping-cough	February and April.

Respiratory diseases attain their greatest prevalence in December and January, while epidemic diarrhœa is at its height in August.

The Animal Parasites of the Skin.—It is unfortunately only too common to find poor and ill-cared-for children suffering from these pests, which they can, of course, hand on to their more cleanly companions. Not seldom has a careful mother, on discovering some little insect on her child's hair, expressed her firm conviction that this unwelcome guest has been received at school, and there is little doubt that this is often the case.

The *Louse*, or *pediculus*, commonly infests the heads of dirty children, but sometimes is met with more on the body or in the clothing than on the scalp. We have thus three varieties: the *Pediculus capitis*, or head-louse, the *P. corporis*, or body-louse, and the *P. pubis.* They are well-known little insects, and lay eggs, popularly termed "nits", which they cause to adhere to a hair by means of a kind of cement. These eggs are not removed by simple washing or by an ordinary combing, and accordingly the head may be thought to be clean when it really still contains many potential insects. These pests cause great itching, and this the child tries to relieve by scratching, which often abrades the skin. These abrasions become infected with germs, and get coated with pustular crusts covering parts of the head, while the glands at the back of the neck may become enlarged. Infection by lice has received a special name, *phtheiriasis*, from the Greek *phtheir*, a louse. The best treatment for the head is to have the hair cut very short (shaved, if possible), and after a good washing with hot water and soap, to apply pure kerosene or petroleum, rubbing it in well. If the head is not shaved, the hairs of any length must be combed with a fine toothcomb to get rid of the nits. For body-lice a hot bath with plenty of soap, followed by the use of either *white precipitate* ointment or *stavesacre* ointment, will generally effect a cure.

The *Flea*, or *pulex irritans*, is another animal parasite, consisting of a small dark-coloured insect provided with three pairs

of legs, of which the hindmost pair is particularly strong, enabling it to jump great distances compared with its size. These parasites bite their hosts, leaving a little mark on the skin from which a small droplet of blood may escape. They readily pass from one child to another.

The Itch insect, termed *Acarus scabiei*, is the cause of that unpleasant complaint known as itch or *scabies*. The insect is a minute tortoise-shaped object, with a projecting head and eight legs. The female forms a burrow in the skin, where it lays its legs, and it is these burrows that are the seat of the great itching. A burrow shows as a dark dotted line, ending in a small white dot. They may be seen in the webs between the fingers and at the inner side of the wrist. The complaint also affects many other parts of the body, such as the hips, and the back between the shoulders. The itching is intolerable and is always worse at night, leading to such scratching that the skin is furrowed by the nails. This complaint is of course infectious. It can be cured by a hot bath, followed by thorough rubbing with sulphur ointment, the rubbing being repeated as often as may be required. Cleanliness of person, clothing, and surroundings is the great preventative.

Vegetable Parasites.—There are only two parasites belonging to the vegetable kingdom that require notice; these are *favus* and the parasite of *ringworm*.

Favus.—This is an affection of the head caused by a fungus named *Achorion*. It shows itself on the head in the form of sulphur-yellow cups, containing yellow crusts, having a mouse-like odour. The hairs are harsh, brittle, and dull, but not necessarily broken off short as they are in ringworm. The disease may also infect the nails. It is said to be more common in Scotland and Ireland than in England, and is prevalent among the Jewish population of Russia, Poland, and Galicia. It is favoured by squalid surroundings. In London it occurs chiefly in the East End. The Education Committee of the London County Council decided in 1905 to open an elementary school for favus cases only, to accommodate eighty children, a separate room for a nurse also being provided.

The disease is contagious from child to child, and may also be given to children by lower animals, as the dog. It may persist for a long time. Treatment consists essentially in pulling out the affected hairs by the root (*epilation*), which can be done with reasonable ease, as they are not so short or brittle as in ringworm. The crusts must be softened by soaking with carbolic oil, or covering with a poultice of starch and boracic acid (one tea-spoonful of the latter to a pint of starch). After the hairs are removed and the scalp clean, one or other of the applications to kill the fungus, as used in ringworm, may be applied.

Ringworm.—This skin affection, due to two or three different varieties of fungus, may attack the head, the face, or the body generally. It receives its name from the somewhat round shape the affected spot assumes. It is exceedingly intractable in the head, and persists for a very long time. The writer has known several cases personally of children in a good position in life who were affected for long over a year. In his report of December, 1905, made to the Education Committee of London, Dr Kerr says that ringworm causes a loss of attendance equal to about one-ninth; he adds that it may persist for months and even years.

When a case of ringworm is seen early, the teacher notices that here or there on the top of the child's head there are one or more round patches contrasting in colour with the rest of the head; in dark-haired children they are of a bluish tint, in fair-haired ones their colour is yellowish-red. They are covered with whitish scales, and the hairs in them are short, dry and brittle, having a length of only a tenth of an inch. They project from the scalp as little black stumps. The patch may be a third of an inch across, or as large as 2 inches in diameter. When the disease has lasted some time, the outline of the patches becomes less distinct, but the scaliness of the scalp persists, with thin, broken, diseased hairs upon it.

Ringworm of the body is most common on the face, sides of the neck, wrists, and hands. It shows first as a slightly raised rose-pink spot, perhaps as large as a threepenny-piece. Its

surface has a slightly scaly look. The spot spreads outwards, and the centre grows pale again so as to resemble the healthy skin, but round it is the pink, slightly-raised margin or "ring". This form of the disease is fortunately easily cured, as a rule, and generally yields quickly to an ointment containing 30 grains each of sulphur and white precipitate (ammoniated chloride of mercury) in an ounce of simple ointment.

Ringworm of the scalp is often very difficult to cure. No teacher need feel surprise if six months or more elapse before a medical certificate of freedom from disease can be given. It is spread by caps, towels, pillow-cases, and actual contact of heads. The treatment to be soon efficacious requires shaving of the head, removal very carefully (by tweezers) of each single affected stumpy hair, and conscientious persistence in treatment as ordered by a medical man. From time to time a headmaster or infant mistress will try to treat cases at school, and the usual remedies applied are tincture of iodine, strong acetic acid, or some form of carbolic acid painted on the patches. The writer would suggest that if teachers are going to use remedial measures they should give a trial to *formic aldehyde.* This chemical, sold by chemists under the name of *formalin*, a clear watery fluid, is a powerful germicide, and has been found of much value in ringworm of the head. One ounce of it diluted with eight times its bulk of plain water will make a stock that will last an ordinary school for the best part of a year. A little may be applied to the patch daily.

With reference to the whole question of these parasites of the head and skin, it is of great value to have women sanitary inspectors to attend at the schools, see the suspected or known cases, and follow them up to their own homes. This is now done in many large towns. In Glasgow, cases of children with unclean heads, or filthy clothing, or uncared-for bodies, are reported to the sanitary authorities, who can deal with them under the Police Act. Headmasters are supplied with special forms. These bear at the top the words: "With regard to children in a dirty state, or houses, bedding, or clothing alleged to be in a filthy condition". Below is the notification as

follows: "I beg to inform you that the ——— is reported to be in a —— condition, and I shall be glad if you will give the matter your attention". This is signed and dated by the head master or mistress and sent direct to the sanitary inspector. Women inspectors visit the schools regularly, and view any dirty children picked out by the teachers. These are followed up, the homes visited, and, if fitting, a warning notice is given to the mother. In persistent refusal to clean the premises the parent may be prosecuted.

In London there are nurses appointed by the Education Committee, who now deal with all kinds of personal uncleanness, though they were originally intended to deal with ringworm cases only. They follow up their school visits by home visits, and in this way they help to obtain better attendance. As a result of this, teachers and school-attendance superintendents are becoming more and more alive to the importance of their work. Writing of them Dr. Kerr says: "The method of working which the nurses adopt is to pay single visits here and there to different schools in their district, but every third week begin a very thorough examination of one school, and pay several visits at short intervals till it is deemed sufficiently cleansed. The teachers should then endeavour to maintain the results of the nurse's work for weeks or months. Managers do not realize the amount of work a nurse has to do, and in many instances have sent in requests for more frequent visits from the nurse, or for greater attention to their particular school, which at present it is quite impossible to afford."

Medical Inspection of School-children

However great diversity of opinion may exist as to the feeding of school-children at the public expense, there is a remarkable degree of unanimity as to the necessity for medical inspection of children in elementary schools. The feeding of children is primarily a private duty; the regard for their health when massed together in schools is a public one. The child with an empty stomach will make its wants known at

home; the scholar with ringworm, or peeling after scarlet fever, will be conscious of no ill, and requires the trained eye to see that anything is amiss. Medical inspection is becoming more and more of an important factor in school life every year. Started first in Brussels over thirty years ago, it is now in operation in nearly all parts of the civilized world. Almost all European countries carry it out, as well as the United States, the Argentine, Egypt, and so forth. In France, medical school inspectors are appointed by the municipality; in Norway, by the municipality under the Board of Education, and so on. Japan alone has nearly nine thousand. New York, Boston, and Chicago have daily school inspection. In Boston, for example, the medical inspector attends every morning and inspects all doubtful cases (previously picked out by the teachers). All ill or suspicious cases are sent home with a note (for the inspectors do not treat the cases), while instances of recognized infectious disease are notified to the Sanitary Board. A medical certificate is required before these cases return to school.

As illustrative of the beneficial results of systematic medical inspection, a few figures may be quoted from a report issued in spring, 1906, by Dr. Darling, Health Commissioner of New York. The system of inspection was reorganized by the Board of Health in March, 1905, and since that time (up to the spring of 1906) the inspectors examined 55,332 children, and reported 18,182 cases of defective teeth, 16,394 cases of defective vision, and 8182 cases of defective nasal breathing. Treatment was resorted to in 33,551 cases. The morbid conditions that occurred most frequently were defective vision, defective teeth, and enlargement of the glands in the front part of the neck; of each of these groups more than 14,000 cases were reported. During 1905, 88,904 visits were paid to schools, and 18,844 children were excluded for diseases of a contagious character. No fewer than 8833 were for eye affections, 4692 for infection with lice, 2018 for skin diseases, 312 for measles, and 74 for diphtheria. In 1903, as many as 65,294 children were excluded, and in 1904, 25,369. The work of the

school nurses is important, as through their ministrations many children are enabled to attend school who would otherwise have been excluded.

There is a very strong feeling in Great Britain that medical inspection should be carried out, and one can easily realize the importance of it when it is remembered how easily an early case of measles or diphtheria may light up an epidemic in a school. Not only for the sake of the school as a whole should inspection be carried out, but also for the sake of individual children. Many a physically or mentally backward child would be saved a great deal of strain if the teacher had a medical adviser to whom the case might be referred for advice and guidance. That such inspection will soon become general all over this country is a certainty. On July 16, 1906, while the various clauses of the late Education Bill were under consideration, Mr. H. J. Tennant moved an amendment to make the medical inspection of school-children compulsory upon the local education authority; and Mr. Masterman added that if the powers proposed in the clause were left in their present *optional* condition, nothing like a satisfactory arrangement would be got. Sir Gilbert Parker asked the Minister of Education to realize that both sides of the House were of one mind on this matter, and among other speakers in support of the amendment were Sir William Anson, Sir William Collins, Mr. Macnamara, Mr. Balfour, and Sir Henry Craik. The latter said: "Medical inspection must be carried out as part of education work; it will not only benefit the health of the children, but will improve their education".

Mr. Birrell, in replying, said as regards medical inspection he agreed it was most desirable to ascertain what kind of people the children were, and how one generation compared with another. Medical inspection was also of great value as indicating to the teachers what congenital weakness the children might have, in order that they might be treated properly in the class. Medical inspection of schools need not be very expensive, and a good deal could be done by nurses, who need not be attached to the schools and doing nothing else. Nurses

would as part of their ordinary duties be perfectly willing to visit the schools. He was willing to submit to the judgment of the Committee that it should be made an obligatory duty on every local authority to provide for the medical inspection of every child on his application for admission to a public school, and on such other occasions as the Board of Education might direct. The Board would be ready to strengthen its own medical staff with the object of ascertaining and keeping in touch with what was going on in Continental countries, from which we had much to learn.

As regards the practical details to be carried out, these will depend on certain local conditions, the size of the school, and so on. Medical inspection should consist of a general scrutiny of all the children, with consideration in detail of all those who are under the standard of weight and height. The latter data would be collected by the teachers at the beginning of each session. To the medical inspector would be referred also all cases of delicate physique. In addition to this periodical and systematic inspection of all children, the medical visitor would attend daily, if possible, for a short time each morning, and would examine suspected and special cases picked out for him by the teacher of each class. These groups of children could be arranged in separate lots in the central hall, or in an empty class-room, and the inspector would decide what was to be done with each. Some would be sent home at once, with an explanatory note or circular; some would be sent back to class, but provided with a note to the parents, indicating that treatment was necessary for, say, defective vision, bad teeth, or other ailment. Others still would be returned to their work as normal. Nurses visiting at home would supplement this inspection, and would see that treatment was properly carried out for such conditions as ringworm, ophthalmia, skin affections, and dirty and verminous states. It is safe to say that within two years of the initiation of systematic medical inspection the whole level of health of the school would be distinctly raised, and much better attendance secured.

Closing of Schools.—Before we leave the question of medical inspection, a word may be said with reference to the closing of schools for outbreaks of infectious disease. Each case must be decided on its own merits. In the case of outbreaks of such serious diseases as scarlet fever, diphtheria, and small-pox, closure is always advisable if the outbreak is extensive. In the case of measles it is somewhat different, and Dr. Kerr suggests as a working plan that if this disease appears in a single class of an infants' school, closure should be applied, but that if several classes have been affected with measles from the first, and especially if several schools in a district are affected, it may be held that the district in general is infected. Experience has shown that in such cases closure is of little use. In general, throughout the metropolis, the method of closing a school because measles is prevalent, and because the attendance has dropped 10 or 20 per cent, has now been abandoned.

CHAPTER XII

Tubercular Disease in School Life—Causes—Infection of Lungs, Glands, Bones, and Joints—The Mortality and Morbidity—Methods of Treatment—Means of Prevention—Rheumatism among Children.

Tubercular Disease in School Life

Tuberculosis is the general name applied to a diseased condition which affects the human subject (as well as many of the lower animals), which shows itself in a variety of ways, and which is due to a definite micro-organism. This organism is called the *Bacillus tuberculosis*, and was discovered by Koch in 1882. Every case of tubercular disease is due to the entrance of this germ into the body, and it is therefore to be regarded as the *direct* or exciting cause of the condition. At the same time, there are various *predisposing* causes, to which reference will be made again, but which include overcrowding, bad air, dark and damp dwellings, deficiency of food, intemperance,

dirt, and ignorance. All of those factors, with the exception of intemperance, play a definite part in the onset of tuberculosis during school life.

Tubercular disease is unfortunately very common, and causes about one-tenth of all the deaths in the British Isles. Thousands die of it every year in our land, and it is also a source of much and prolonged ill-health. It specially attacks the young—children and young adults,—and in the form of tubercular disease of the lungs (phthisis or common consumption) it caused 40 per cent of the deaths between the ages of twenty and forty-five in England, in the period 1894–1903. In some of its other forms, as we shall see, it falls still more heavily on young children.

When tubercular disease attacks different parts of the body, it varies somewhat in its effects. In some cases death will occur early; in others reasonable health may be enjoyed for a long time, or the condition even be cured. For example:—

1. The skin may be affected, leading to the condition called *lupus*, an ugly ulcerated patch on the cheeks and nose. This is disfiguring, but comparatively mild.

2. The glands, particularly those on the side of the neck, may be attacked. This is rather more serious. The great majority of cases of enlarged glands in the neck are tubercular. This condition is sometimes called "scrofula" in more or less popular terms. In old times it was named the "king's evil", and it was believed by sufferers that they could be cured by the royal touch. Queen Anne was the last English sovereign who performed this ceremony, one of her patients being Dr. Samuel Johnson. Tubercular glands of the neck have a great tendency to soften and suppurate, discharging matter. They may in this way cause long-standing ill-health, and when the sore heals, an ugly scar is left.

3. The bones and joints may be attacked, producing still more serious results. Children are very liable to this form of the disease. Ordinary "hip-joint disease" is tubercular disease of the head of the thigh-bone, and "white-swelling" of the knee is the same affection in that joint. A visit to the surgical

wards of any of the sick children's hospitals of this country will show what a large number of the little patients are afflicted in this way. In some instances death claims the victim; in others, life is spared, but the child is so crippled as to be unable to attend an ordinary school, and in after-life is debarred from many ways of earning a livelihood.

4. In the next place, we have the lungs, kidneys, and bowels affected. In the case of the lungs we get ordinary consumption, and this is at present a terrible scourge in all parts of the world. In most cases it carries off the sufferer in a time varying from a few months to a few years, though of course some sufferers live for many years, always delicate, and a few recover altogether. We look forward now to many more cures by the aid of sanatorium treatment. Consumption of the lungs, or phthisis, is always accompanied by expectoration or spit, and cough, and in the expectorated matter many thousands of bacilli are daily cast out of the body. The bowels may likewise be affected, leading in most cases to death fairly soon, and the membrane which envelops them, the *peritoneum*, is another seat of attack leading to tubercular peritonitis. Tubercular disease of the kidneys and other internal organs may occur, and is always grave.

5. Lastly, the membranes of the brain (*meninges*) may be attacked, giving rise to tubercular *meningitis*. This terrible variety specially selects young children for its victims, and it is always fatal. It is very rapid in its course, the sad ending often coming within four or five days.

All parts of the body may be affected in childhood, but the glands, bones, and brain are the chief seats, the lungs and bowels coming next. Let us look at the figures for 1902, and note how many young lives were sacrificed to tubercular disease. (1) In that year there were 5921 deaths from tubercular meningitis, of which 4056, or 68 per cent, were under five years. (2) There were 5303 deaths from tubercular peritonitis, of which 3815, or 72 per cent, were under five years. General tuberculosis that year claimed 4048 victims, of whom 50 per cent were under five; and there were 1413 deaths from

the disease attacking bones, joints, and other organs. In that year the death-rate from tubercular disease, under the age of five years, was 3·09 per thousand, while the death-rate from all causes was 49·07; in other words, of every fifty children dying under this age, three at least succumbed to tubercular disease.

These facts have been insisted on, in order to impress on school teachers the seriousness of this affection, so that they may take every precaution within their power to limit its spread. Consumption does not arise spontaneously. No child can get tubercular disease of glands, bones, or lungs through simply being underfed or getting a chill. In all instances the disease is started by the germ of tuberculosis entering the system—the underfeeding, dirty housing, and chills simply acting as predisposing influences. Those weaken our natural resisting powers, so that we fall victims the more readily. No doubt we all breathe in or swallow germs of tubercle many times in our lives without becoming consumptive. This is because our health happens to be good, and the germ's entrance is resisted by the vigorous body tissues and cells. On the other hand, a weakly child may readily be infected, because resistance is so feeble. The great fact, however, remains clearly defined: tuberculosis is an *infectious* disease, and should be treated as such. In the London County Council School Management Code (April, 1904), under Article III. (Sanitary Conditions of Schools, &c.), Clause C (IX), we read: "Consumption is to be regarded as dangerous, and sufferers must be excluded if this disease is accompanied by coughing or spitting".

We come now to the practical question of what is to be done to limit tuberculosis in schools, especially as concerns the teacher. In the first place, we have to deal with the *exciting* cause, or germ, of the disease. This is conveyed to children in one of two ways—(1) taken in milk, and (2) breathed in from the air. The teacher in an elementary school has practically no control over the first of these; that is a point to be dealt with by the Public Health Authorities. But the matter is

different when we turn to the second mode of infection—the breathing-in of the microbes of the disease. Children do not have tuberculosis of the lungs as often as they have that of bones or joints; but, on account of the expectoration in lung affection, the latter is infinitely more dangerous as a source of infection. It has been already mentioned that the spit may contain thousands of bacilli or germs every day; and a child in this state is able to infect many others, giving rise to tuberculosis in them in various parts of the body. What happens when a child with phthisis expectorates on the floor? As long as the spat-out matter remains moist no harm follows; but it soon dries up, becomes ground down under countless heels, and the resulting light dust, with the impalpable and almost imponderable bacilli, floats through the air, is breathed in by children all around, and lodges also on any presenting resting-place, ready to infect on another day if not on that. These germs, dried and kept in a dark part of the room, will retain their vitality (and therefore their power of doing mischief) for many days.

To combat this, we may lay it down as a definite rule that children with consumption of the lungs (with the accompanying spitting) should not attend school. What is to be done with them will be considered later. By this means, the foci of mischief would be excluded. In London, it is laid down that such children should be excluded, but teachers apparently often disregard the rule, and besides that, many a teacher might reasonably think that the child had simply an ordinary cold, with some coughing-out of phlegm from the chest. The writer does not think teachers can be expected to tell which children have phthisis, without medical guiding. There will therefore always be the chance of some children with tubercular expectoration attending school. The next point, then, is to insist that no child who needs to cough or spit, expectorates on floors, whether in class-rooms, corridors, or playgrounds. There is no question that the great means of spreading this disease is dried expectoration, therefore it must be kept in check. Now, if a child needs to spit, it can do so, either into a pocket-

handkerchief or into some form of spittoon. The former plan cannot be commended, for we simply have the bacilli drying on the cloth instead of on the floor. Indeed consumptives ought never to use handkerchiefs for coughing into, but little squares of rag or paper which are burned *while still moist.* The burning of rags or paper is not feasible in many schools, on account of there being no open fire, whether heating is done by hot-water pipes or hot air. The writer strongly recommends the use of spittoons. They are already widely used in public places in Germany, and ought to be in this country too. Large ones of enamelled iron or iron-ware could be placed, say, at each corner of main corridors, and of the central hall, in the playgrounds at certain points, and perhaps one or two in the lavatories and cloak-rooms. In class-rooms a few small enamelled iron spittoons, such as are used in hospitals or sanatoria, could be supplied. In every case these articles should contain a little crude carbolic acid, and it would be part of the janitor's duty to see that the disinfectant was put in fresh each morning, and that every spittoon was emptied down the water-closet every evening. It may not be a pretty sight to see a child expectorating into a spittoon; but we are dealing here with a matter of health, and with a disease so fatal that it carries off thousands upon thousands in this country every year, and it is infinitely preferable to see that a child uses such an article than to let it cough up matter into its pocket-handkerchief or on to the floor. As long as children are allowed to come to school who cough or spit, every precaution of this kind must be taken.

Although it is mainly by the infective matter in coughed-up mucus that tuberculosis is spread in school life, it is quite possible to have it communicated by the discharge from a suppurating gland in the neck. No child with any matter coming from a sore on the body, and especially from an enlarged gland or other likely tubercular focus, should be allowed to attend school.

Again, dried sputum becomes part of the dust of the rooms, and therefore a war should be waged against dust. The school-designer should leave as little as possible in the way of pro-

jecting knobs, cornices, and such like on which it may lodge. The teacher ought to insist that the room is well dusted, and the walls must also be kept clean, and rubbed down regularly. The floors should be sprinkled before they are swept. Fresh air in large volume should be admitted at all intervals, as it dilutes the germs in the air of the room and clears them out. Other points must be attended to, such as forbidding the biting and sucking of penholders and pencils, the interchange of handkerchiefs, the licking of slates, and playing on the floor. These are the means by which we can best deal with the active or exciting cause of tuberculosis, and the children can be taught to carry out these general principles at home, and in their own homes by and by when they are married.

The predisposing causes are no less worthy of attention, because much can be done to limit the incidence of the disease by making the child less susceptible to it. There are variations both in the susceptibility of the individual and the virulence of the bacilli. The teacher cannot affect the latter, but can influence the former, at least in certain respects. Everyone hears of *heredity* in consumption and certain other diseases, and the study of large numbers of cases shows that a history of the disease in the parents, brothers, and sisters of the patient occurs in about 33 per cent (C. J. B. and Theodore Williams). What, now, do we really mean by heredity here? Do we mean that the child is born with the disease, inherited direct from a diseased parent? No, that is not the meaning of heredity; for while it is quite true that a very very few instances are known where the child was born already infected, where the germ had passed directly from the mother into the unborn babe, yet these cases are so rare as to be hardly worth considering. What we do mean by a hereditary tendency is that the individual has inherited a narrow or flat chest, overlarge tonsils, narrow nostrils, defective circulation, or some innate weakness of resistance to infection, any of which render him more likely to fall a victim than his healthy neighbour. We see, then, that even over hereditary tendencies the teacher has some control.

Other predisposing conditions include bad feeding and bad home-conditions, which are largely beyond the teacher's powers to improve. They include also badly-ventilated class-rooms, stooping at work (which contracts the chest), the presence of draughts which may cause colds—and an ordinary cold is often a good foundation for the germ of consumption to build on. What the teacher can do here is much. He or she can see that rooms are well ventilated without draughts; that children sit up well at work, that the desks are suitable, and that the poor-sighted wear glasses; that delicate children get a longer time in the playground, and that exercises suitable for the chest are regularly performed. Every teacher should keep in mind the value of singing as a means of expanding the lungs; the child takes in much air without thinking about it, and in the course of a pleasant occupation. Swimming is another means of great value for expanding the lungs, as are also gymnastics generally, and all "breathing" exercises. Special attention should be paid to bad positions which impede the full expansion of the lungs, and children with ordinary colds should not be overlooked, as a common catarrh is often the starting-point of tubercular disease. Always let the teacher keep in mind that this is an infectious and acquired disease, needing the entrance of a definite germ into suitable soil, and that it is therefore a *preventable* disease. It was a recognition of these great facts that enabled the late distinguished medical officer of health for Glasgow, Dr. James Russell, to reduce the death-rate of this dire disease by no less than 40 per cent within a period of thirty years! Let that be the reply to those who contemptuously deride, as uncalled-for and finicking, such measures as the prevention of spitting, the use of spittoons, the exercise of the chest in various ways, and an abundant supply of the purest air available.

There still remains a matter to be touched on, and a very important one it is. This is, what is to be done with the children already suffering from tubercular disease, or more especially those who suffer from this disease in the lungs, *i.e.* ordinary consumption? These are the cases which most

readily infect others, and these are they who really ought not to come to school. What is to be done with such a child? Is it to be excluded from school and sent back to the house where it perhaps contracted the disease, or to play on the streets, gradually deteriorating in health, and all the time perhaps infecting others?

The only answer that can be given is that the young sufferers must be sent to sanatoria, and that these sanatoria must be provided by the State. What we aim at in these young subjects is *cure*, and for good results there must be early admission and long residence. Inattention to these two essentials, or inability to meet them, accounts for the indifferent results so often obtained at the present time. In France the importance of early treatment of the disease is recognized both by the laity and the medical profession, and sanatoria exist for the treatment of children from two years and upwards. Dr. Ménard says that three years' systematic treatment by good food and fresh air are required for the cure of cases of tuberculosis of bones and joints. He says that great cities like London, Paris, and Berlin need a thousand beds for children, at sea-side places, per million of the population. There are practically no sanatoria for young children in this country—certainly none where cases as early as two years old are admitted. In France the youngest child at school, or any child over two years, who shows signs of tuberculosis is sent off to one of the sanatoria maintained by the "Assistance Publique" or by some charitable agency.

In Germany, Austria, and Switzerland, use is made of holiday homes, where delicate children can be sent, while in Denmark there is a system in vogue whereby an exchange of town and country children is carried on. This is said to be extensively made use of. What one would like to do in this country is to transplant our elementary schools from the great cities to the country, from the smoke and fog of London, and Glasgow, and Manchester, to sweet, quiet, rural districts, or at least to board delicate poor children in the latter.

Rheumatism among Children

We are apt, perhaps, to associate the term rheumatism with stiff joints, lumbago, and enlarged knuckle-bones, and to consider it a complaint from which children are free. As a matter of fact, children are attacked much oftener than was formerly supposed, only the condition shows itself in different ways to what it does in the adult.

Rheumatism, at least acute rheumatic fever, is now regarded as being in all probability an infective illness, due to the entrance of some micro-organism into the system. This may appear surprising to those who have always thought of it as some general complaint brought on by damp or cold. There is no need to enter here into the arguments in support of this view, but it may be added that they are strong, and are steadily gaining ground in the medical profession. Chill and damp probably play the part simply of predisposing factors, just as they do in tuberculosis. In the adult, rheumatism specially attacks the joints, leading to stiffness and to enlargement of the ends of the bones, and in its acute form it is very apt to attack the valves of the heart. Here it causes inflammation, and thickening, and at last shrinking of the valves, so that ever afterwards the patient has an affected and diseased heart.

In children, on the other hand, there may be little of the joint affection, that which is so outstanding in adults. In any case, acute rheumatism is rare in young children, but it may occur in an apparently mild form and do a good deal of mischief. For example, it really may attack the joints, and yet the child is considered to be suffering merely from "growing-pains". What are growing-pains? Is it really painful to increase in stature? As a true matter of fact, when a child complains of such aching, say at the knees, it is in every degree probable that he is suffering from rheumatism. Now rheumatism, as already mentioned, has a great tendency to affect the heart's valves, and the result is that the child may develop valvular disease without anyone suspecting that he is suffering anything more than these mysterious growing-pains. The

unfortunate thing is that rheumatic inflammation of the valves can often be averted or even cured if the patient is kept quiet and resting in bed, and the chance of doing this is lost because no one has recognized that what the child is really suffering from is rheumatism. A child may thus get a damaged heart at the age of six, that may cripple his whole life.

Whatever be the exact cause of rheumatic infection it is greatly aided by hereditary tendency, and by bad hygienic conditions. The preventive treatment is largely beyond a teacher's powers. Good flannel underclothing, warm stockings, and plenty of milk help to keep it away. When any child complains of growing-pains, of breathlessness, palpitation or pain at the heart, or has a bluish tint on the cheeks or lips, the teacher should do everything possible to induce the parents to have the child medically examined, and should at all events, for the time being, exempt the child from all physical exercises. These symptoms indicate affection of the valves of the heart, but may also occur, in a somewhat less marked degree, in cases of *dilated heart.* Dilatation of the auricles or ventricles is not infrequent in childhood, especially where anæmia exists, or after an acute illness like scarlet fever. Physical exercises in such a case make matters worse, and no child with any of the above symptoms should take part in them till medical sanction has been obtained.

CHAPTER XIII

The Physically Defective and Feeble-Minded Children — Necessity of Special Departments, and Appropriate Means of Teaching.

The Physically Defective and Feeble-Minded.—The care of children of this class involves special considerations, and this manual would lack completeness if some mention were not made of this matter. It is obviously in every degree unsuitable that children so afflicted should be taught along with those of complete bodily and mental vigour. The latter suffer

because they must be kept back to let the infirm keep up with them, while those feeble in body and mind are under a disadvantage in that they cannot receive the detailed attention they require. Taking the case of physical exercises, the cripples must either attempt the lessons of the ordinary physical code or be deprived of exercises altogether, if they are in a mixed class. In the next place, the very style and arrangement of the room must be altered to meet the case of the crippled. They cannot sit in rows in ordinary desks as their more fortunate companions can. For the feeble-minded, too, special means of instruction are required, specially skilled teachers, and special conditions, which cannot obtain in an ordinary class. Children, again, one regrets to say, are very callous as regards the infliction of bodily and mental pain, and the presence in a mixed class of those feeble in body or mind is only too apt to lead to the latter being teased, mocked at, and bullied. If all those who are weak in body are taught together, there is little risk of this, a common bond of sympathy uniting them, while among those feeble in mind no one is so very bright as to be able to make game of his neighbour. For these and other reasons those two classes must be kept apart from the rest, and, again, from one another.

In large cities it is best to establish special departments for these classes, as "centres", one establishment serving for a whole district, as in the case of swimming-baths and certain other educational adjuncts. In this centre both the feeble-minded and physically-defective children of the district may be looked after and taught, in separate classes, of course. This department can be quite well arranged as an annexe to an ordinary primary school.

The Feeble-Minded

This includes all the children whose intelligence is so far below that of an ordinary stupid child as to single them out for special attention. In this class are placed (*a*) those congenitally defective in mental powers (the greater number), and (*b*) those with acquired mental inefficiency. The former vary natur-

ally in their powers, some being (for them) very bright, others extremely dull. In some the mental weakness can be traced to no known physical cause, in others it may be associated with injury to the brain at birth, or unduly small size of skull (microcephalus), preventing proper brain-development. Among those who suffer from acquired mental feebleness we find the epileptics. A boy or girl may appear quite normal in the early years of life, and may then develop epilepsy, one of the most terrible of bodily and mental afflictions. It is characterized in ordinary cases by an epileptic attack or fit; the child may cry out, falls, loses consciousness, and has a sharp convulsive attack, lasting one to two minutes. During the attack the face is contorted, often looks blue from the want of respirations (the chest muscles being in a state of spasm), and the tongue may be bitten. Sometimes the child will pass water or the bowels will move involuntarily. The attack is followed by a period of mental dulness and apathy, sometimes by a spell of sound sleep. Epileptics often hurt themselves in falling, and have been burned by coming in contact with the fire, or drowned by having an attack when bathing. No epileptic should ever bathe, and in a room where such a case is, the fireplace ought to be well guarded.

In managing such cases, all that a teacher can do is to take every precaution at the time to save the child from injury. In a certain number of cases, epileptics have a warning (technically called an *aura*) before the fit comes on. This warning usually takes the form of some special sensation, such as the feeling of cold water running over the skin, or a peculiar smell, and enough time may elapse between its appearance and the fit, to allow of the child placing himself in a position of safety. It has been known, too, for many past ages, that in some cases the fit may be averted if a band be fastened tightly round a limb, especially if the warning sensation be felt first in that limb. Suppose, for example, that a girl in the class is epileptic, and is able to tell her teacher that she knows when a fit is going to come on by a burning sensation at the finger-tips. It would be quite reasonable to make the child wear a loop of stout tape

fastened with a slip-knot upon that arm, so that on the sensation being felt the band might be immediately pulled tight.

As a rule, however, the fit comes on, and the best the child can do is to lie down on the floor, clear of any benches or desks. If the attack comes on without warning, the child will fall on the floor or on to the desk. He should at once be laid by the teacher on the floor, clear of furniture; the head should be slightly raised on a folded coat to facilitate breathing, and the collar and other clothing about the neck made perfectly loose. It has been pointed out that the tongue may be bitten; this can be avoided by forcing the teeth apart with a paper-cutter or thin strip of hard wood, and inserting a cork, or a pencil wrapped in a handkerchief, between the jaws. If a cork is used, a string should be attached to it to enable it to be withdrawn should it fall into the mouth. Several clean, small medicine corks, with a string attached to each, can be kept at hand in the teacher's desk in such a room as this. No attempt should be made to get the child to swallow anything during the fit or shortly after it, and any foreign substances in the mouth should be fished out with the finger for fear of choking. As a rule, the child falls asleep after the fit, and remains so for a few hours, waking up either well, or dull and stupid. Vomiting may occur during the fit or after it, and in view of the latter contingency the child should never be allowed to lie on its back to sleep. The side position is the safe one.

Epilepsy is, unfortunately, fairly common in children. Sir William Gowers says that 75 per cent of all cases originate before twenty years, and that 25 per cent come on before ten. Girls are more commonly attacked than boys. Unfortunately, in a certain number of cases, especially where the fits have begun early in life, a gradual mental deterioration may supervene, and some of these cases are usually seen in the schools for feeble-minded children. In all cases there is a tendency for the keenness of the intelligence to be dulled, and the memory impaired.

The feeble-minded children often speak very badly. Speech is under the control of a definite centre in the brain, and in a

bad-nourished, under-developed brain this centre suffers like those whose function is intellectual. It will be noticed, too, how badly these children walk, and how awkward their movements. This is due to the same cause—imperfectly-developed brain-centres, in this case for movements. In the management of these children a head-mistress and an assistant are requisite. Much patience is needed, and a gentle firmness. Two to three hours of the school life should be devoted to mental training, and everything must be made as concrete to the children as possible. Many of them read wonderfully well,—thanks to the phonetic system of teaching, which suits them very well. The more stupid may be taught simple reading by means of stories printed in large type on linen, in which the nouns are replaced by coloured pictures. Arithmetic is difficult to teach, as these children can hardly grasp abstract ideas of the relations of numbers, but much can be done by the aid of mechanical aids here (coloured balls on wires, arranged in special ways).

A considerable part of the school time must be devoted to some form of manual occupation, such as paper-box making, mat-making, moulding in plasticine, sewing, knitting, and the like. Some of these occupations, such as mat-making, may be turned to useful account by and by, in the way of a means of livelihood. In any case they occupy the attention, train the hands to co-ordinated movements, and educate the brain, thus forming an essential part in the education of such children.

An effort should be made to give these children some form of physical drill. It is almost impossible to get, say, twenty of them to attend at one time and follow out a teacher's instructions, but they can be taught to do at least the simpler arm and body movements. These, by making demands on the cerebral tissue, lead to development of the motor centres, and conduce to an improved physique and better carriage.

The sexes may be taught in one room, girls on one side, boys on the other, and sharing common apparatus and means of teaching. If the number of children is large, the sexes may be separated. It must be insisted on that the parents send

the children to school in a cleanly condition, and, as a rule, the children can be kept so at school. They can usually be taught quite well to ask, when they wish to go to the lavatory, and little difficulty is experienced in this respect.

The Physically Defective

In any given centre these children usually exceed the mentally defective in numbers. For their care a head teacher is required, with one or more assistants, and on the average there should not be more than twenty children to one teacher. The children (boys and girls) may be taught in one room, which must be specially large, well ventilated, and bright—this being a necessity on account of the inability for active exercise which is the unfortunate lot of these children. The room requires to be differently furnished to the ordinary class-room. At one side there should be a few rows of ordinary desks, long or dual, for children who can use them. Along another side may be arranged several long, low chairs of wicker-work on which children can recline. These should be low, should have broad armpieces, and perhaps a movable part at the foot. One or two ordinary low couches, covered in American cloth, may be added with advantage. Along a third side of the room may run a long, low bench on which the children may rest during the intervals of physical exercise. The centre part of the floor is partly kept as open space, partly occupied by low tables with suitable chairs or seats, at which various manual occupations can be carried on. There must be a couple of black-boards at least. It is a good plan to add to the equipment an apparatus consisting essentially of parallel rails on wheels, in which a lame child can rest and push herself about the room.

The children met with in such a department include the following:—

1. Those who have been so severely attacked by rickets in early years that they are permanently deformed—in some cases practically unable to walk at all.

2. Those who have marked curvature of the spine, which unfits them for ordinary class-work.

3. Those who have been the victims of tubercular disease of joints and bones, now healed, yet having produced permanent stiffness and deformity, *e.g.* old cases of hip-joint disease.

4. Those with deformities caused by repeated attacks of rheumatism.

5. Those suffering from various forms of paralysis. Some of these cases are instances of the disease named "infantile paralysis", due to disease of the spinal cord, and appearing perhaps during the second year of life; after such an attack, a limb may remain permanently shrunken. Other cases of paralysis are due to disease of the backbone, leading to pressure on the spinal cord, so producing paralysis of both legs. Others, still, suffer from paralysis dating from birth.

6. Those suffering from heart-disease, either congenital heart-affections or those acquired through attacks of acute rheumatism.

7. Epileptics.

8. Other cases of deforming or disabling bodily illness.

It is obviously not an easy matter to teach all these children, differing as they do in age and in mental ability. The work must be planned very carefully. These children, it must be remembered, are in possession of reasonably good faculties, but they are not especially clever. The writer has been told by an experienced teacher in this kind of school that it is not the case, so far as she has seen, that mental brilliancy accompanies these feeble frames. Intelligence, on the contrary, is barely up to the average. This is due to the fact that the crippled child in the poorer classes is kept much at home, unless he can be sent to a special school; and if at home his mental outlook is very limited, he forms few new concepts, and does not have his faculties sharpened by contact with other children.

Physical exercise must not be considered an impossibility for these children. Many, if not most of them, can take part in exercises, but these must be modified from the ordinary

scheme, and adapted to their special needs. A well-trained instructress is essential, and those with affected hearts should not take part. Twenty minutes of systematic drill three times a week might prove sufficient. The children should always have a longer playtime than their stronger brothers and sisters. A break of an hour and a half at mid-day is desirable.

In a special school of this kind any particular bent or talent shown by a child should be fostered and cultivated, in order to make it a means of livelihood if possible. The lot of the poor cripple is often a very hard one, and it is most desirable that everything should be done to enable him to earn a living. All the children should be taught to use their hands for practical work, and any boy or girl showing special talent in drawing or painting, carving or fret-saw work, modelling or designing, should be encouraged and helped.

These children cannot, in many cases, walk to or from the school. They must be conveyed, and it is well to have a special ambulance-wagon for such a department. All those really unable to walk can usually be brought in two batches, the older children at nine o'clock, the younger at half-past. In the same way they can be taken home in two lots at half-past two and three o'clock. If the weather is fine they can be taken for a little drive on their way home.

All this is well enough in the great cities, but the matter is not so simple in rural districts or in small towns. The only solution here seems to be a central institution for several country or provincial schools, coupled, if the distance for conveyance is too great, with a system of boarding. The lot, however, of crippled or mentally-defective children in remote parishes is not a very favourable or happy one.

CHAPTER XIV

The Code of Physical Exercises—The Aims of the latter—The Anatomical Principles underlying them—The Actions of the Principal Individual Muscles—The Groups of Muscles employed in performing any specified movement.

Code of Physical Exercises.—In this Code, which is adapted for public elementary schools, we find a complete set of exercises calculated to bring into action all the great muscles of the body. In a preface taken from the Report of the Inter-departmental Committee on the model course of physical exercises, we find this recommendation—that the exercises should be suitable, should need no apparatus, and should be severely practical. Playground space is requisite, as well as a central hall or large class-room for indoor drill.

The primary object of such exercises is to improve the health and physique of the children. How this is accomplished has been already considered in Chapter VI. At the same time these exercises are *educative*—they lead to certain improvements in mind and morals. They make the pupils alert, decisive in action, prompt to obey, attentive, and they increase the control of the mind over the body. The changes that may be produced in this way are sometimes extremely striking. But the primary effect and object is physical.

I. *Physical Effects.*

A. Nutritive exercises, which improve the circulation and respiration. In Chapter VI these points were referred to. All exercise means muscular activity; this calls for a greater supply of oxygen and nutritive particles to the muscles, and the heart and lungs act more energetically to supply these needs. These nutritive exercises include various kinds; thus we have:—

(*a*) Massive exercises; general gross movements of the body as in spontaneous play.

(*b*) Breathing exercises, and all those that expand the chest and so increase the lung capacity.

(*c*) Resistance exercises, and those involving lifting. These

should be used with great care in young children, and are indeed better avoided.

B. Corrective exercises, which aim at overcoming and curing physical defects and deformities. This subject has been touched on already in Chapter VIII. The conditions most amenable to treatment by these corrective exercises are round shoulder, projecting shoulder, lateral spinal curvature, narrow chest, and flat-foot.

C. Control exercises. These include such forms as balance exercises, which train the nervous system, and increase the fineness of its control over muscular action. Even the simplest voluntary movement is initiated by a message sent out from the brain along a motor nerve (see Chapter VI), and the simplest action, often repeated, increases the power both of brain-centre and muscle. When a delicate and complex action, involving the simultaneous use of perhaps six or eight muscles, is performed, the call on the brain for clear stimulation, and on the muscles for prompt response, is much increased. These exercises therefore increase the efficiency of both nervous and muscular systems.

II. *Educational Effects.* These have been already referred to. They are most marked early in the process of learning the exercise, that is, during the time the child has to concentrate its attention on the business in hand. Gradually the movements are performed automatically in response to the word of command. The educative effect is then over, and only the physical remains.

In conducting the classes, the *Formal* lessons must be given first, those that aim at a definite purpose, and which have been specially thought out to meet a certain desired end. After this should follow *Recreative* exercises. The weakly, deformed, and breathless are recommended to have either very little or no exercises; in the writer's opinion they should have some, but of a special kind, and apart from the ordinary children.

The Anatomical Principles underlying the Exercises

The muscles exercised directly are *voluntary* or under the control of the will, and as a result of this, there is indirect improvement in the tone or strength of *involuntary* muscle, such as that of the heart, lungs, and intestines. A muscle when put into action contracts, the belly of the muscle grows larger, the ends or tendons approximate (fig. 52). As these tendons are almost always attached to bones with an intervening joint, it follows that as the muscle contracts the bones are moved and the joint is bent. Or, put in another way, whenever we bend a joint we make a muscle work. All the exercises in the Physical Code, it will be noticed, consist in bending or extension of joints, thus exercising the muscles which pass over these joints. The kinds of movements accomplished at joints receive different names, such as:—

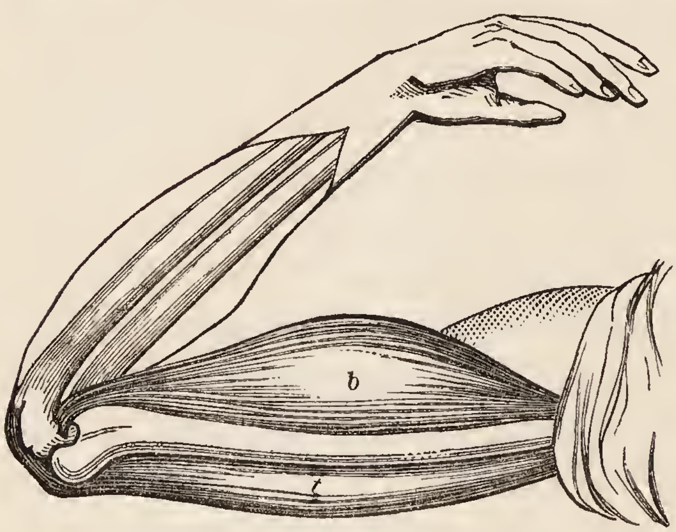


Fig. 52.—Biceps and Triceps Muscles

This figure shows the biceps muscle (*b*) contracting so as to draw up the arm. When the arm is again straightened the triceps (*t*) has a swollen appearance, because it has contracted and become thicker.

Elevation and *Depression.*—Seen when the whole arm is raised outwards from the side to a horizontal position, and then brought close to the side again.

Abduction and *Adduction.*—These terms are applied to leg movements, as when the whole leg is swung out from the other, and again brought back to its original position.

Forward and *Backward* movements.—These occur both in the upper and lower limb, and indicate movement of leg or arm outwards in front of the person, and then back, and outwards behind him.

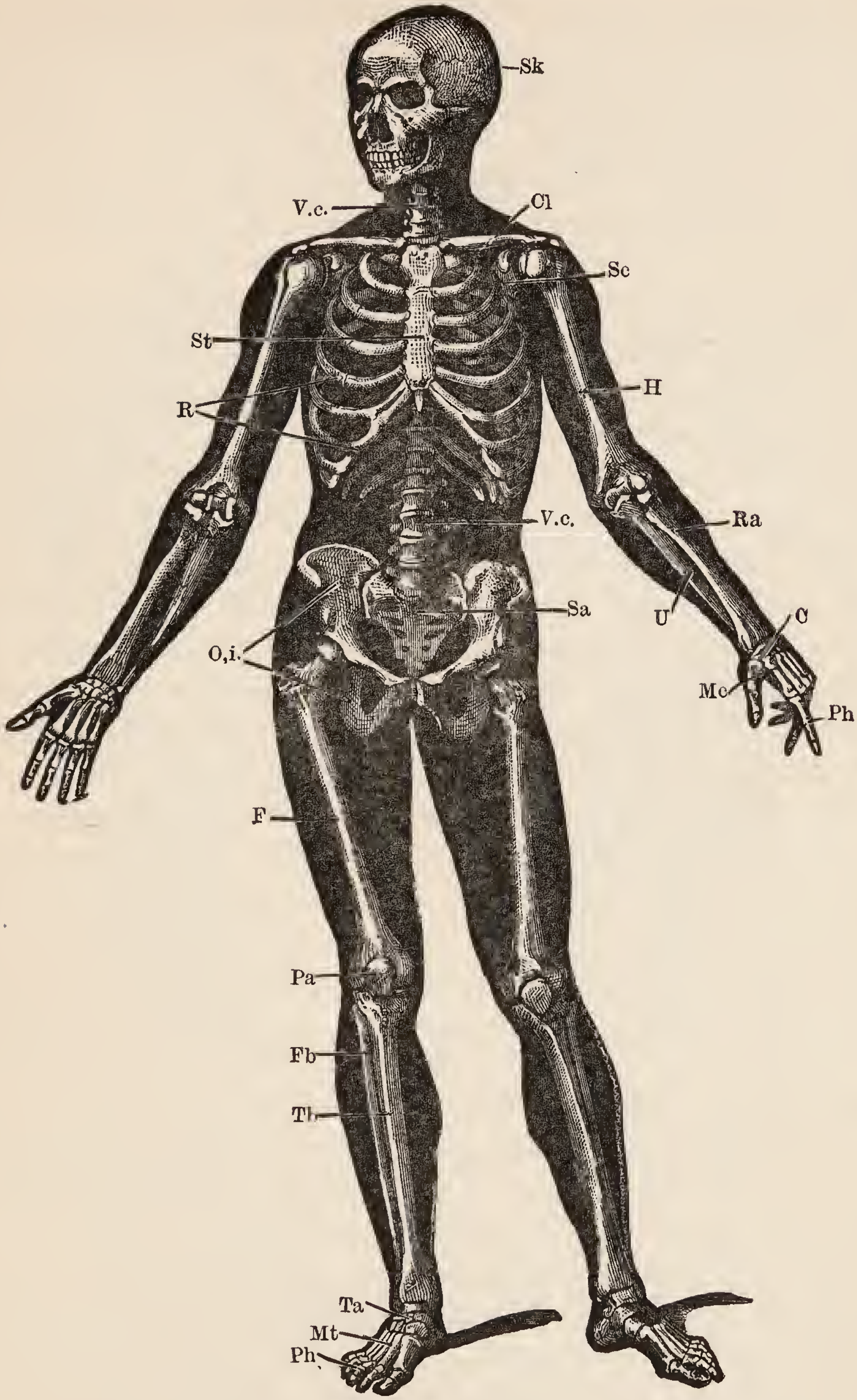


Fig. 53.—Skeleton

Sk, Skull; V. c., vertebral column; Sa, sacrum; St, sternum; R, ribs; Cl, clavicle; Sc, scapula; H, humerus; Ra, radius; U, ulna; C, carpus; Mc, metacarpus; Ph, phalanges; O. i., os innominatum; F, femur; Pa, patella; Tb, tibia; Fb, fibula; Ta, tarsus; Mt, metatarsus; Ph, phalanges.

Flexion and *Extension.*—These terms are often applied to the movements at joints in the course of a limb, such as the knee- or elbow-joint, and imply a bending of the limb at that joint, and then a straightening of it again. But the same words may apply to the great movements of the trunk, which we flex when we bend forwards, and extend when we straighten ourselves.

Rotation movements.—These include certain special terms. In the upper limb we speak of *supination* and *pronation.* If the forearm is lying on its hinder aspect on a table in front of us, with the palm up, it is said to be supine, and that movement of the wrist by which the hand falls over so that the palm faces downwards is termed pronation. The movement by which the hand is restored to its original position is supination. If the leg be stretched out, with the toes pointing forwards, that movement at the ankle whereby the sole is turned in slightly and made to look towards the other leg is named *inversion.* The movement by which it is made to look slightly outward and away from the body is *eversion.*

The Framework of the Body.—The skeleton forms the framework of the body, and consists of bones of various sizes and shapes, articulated or jointed to one another (fig. 53). The apposing surfaces at a joint are covered with gristle or cartilage to allow of smoother movement, and the same substance forms discs between the bodies of the vertebræ, and completes the length of the ribs in the chest. It will be noticed that the spinal column forms the central axis of the body, and carries on it the skull, protecting the brain and the chief organs of sense (see fig. 33). Below, the spine ends in the broad, wedge-shaped sacrum, which in its turn is wedged in between the two halves of the hip-girdle (pelvic girdle or pelvis). From the dorsal part of the spine spring twenty-four ribs, twelve on each side, which curve forward to form the cage of the thorax, and are joined in front either to the breast-bone (sternum) or to one another. The eleventh and twelfth ribs, however, on each side are free in front (fig. 54).

On the back of the chest, near its upper part, lie the two

shoulder-blades (scapulæ), one on each side. Each is a triangular bone (fig. 55), and has two bones articulated to it at its upper and outer angle. The bones are the collar-bone (clavicle), which reaches from the scapula inwards to the breast-bone, and the upper-arm bone (humerus). The collar-bones serve the function of keeping the shoulder-blades braced out from the chest. Were it not for them the tip of the shoulder on each side would fall forwards and inwards, narrowing the upper part of the chest. The upper arm has but one bone, the forearm has two—the radius

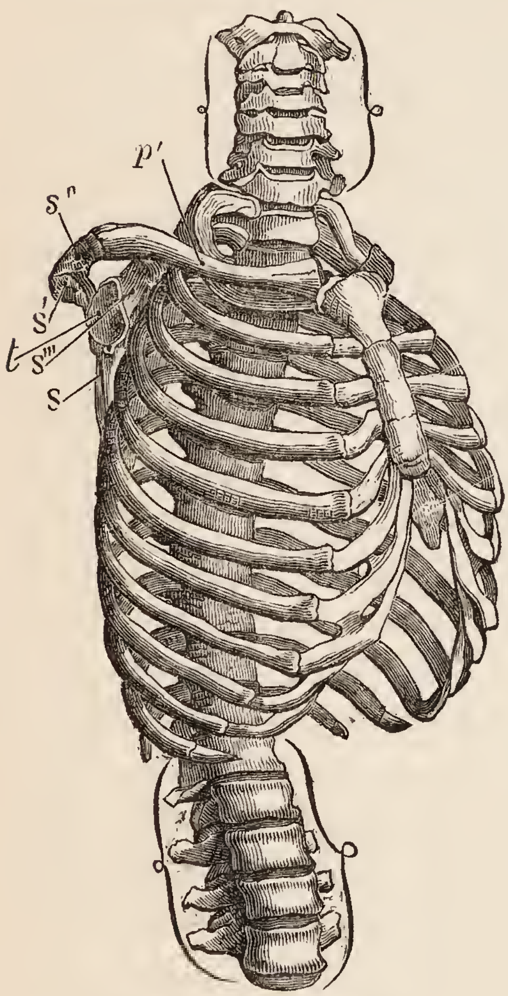


Fig. 54.—The Thorax

The upper vertebræ enclosed in brackets are cervical, the lower lumbar. *p'*, Clavicle; *s t*, scapula; *s' s'''*, glenoid cavity; *s''*, acromion.

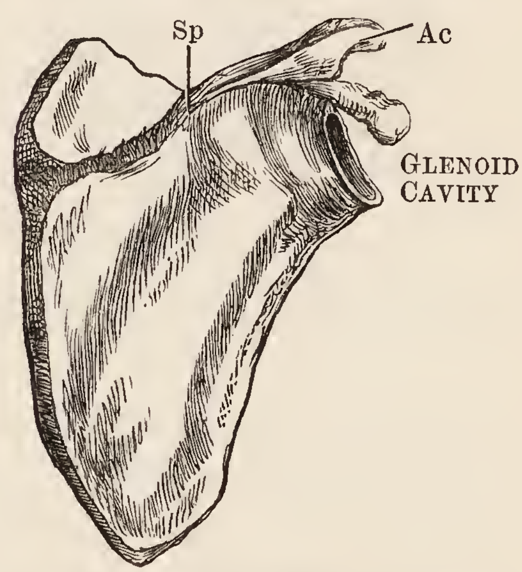


Fig. 55.—Outer Surface of the Right Scapula or Shoulder-blade

Sp, Spine; Ac, acromion.

or shorter of the two, lying to the outer side when the arm rests with the palm upwards, and the ulna, the longer of the two, lying at the inner side. This latter, by its joint above between it and the humerus, forms the elbow-joint. The radius and ulna at their lower end form the wrist-joint, there being eight small wrist-bones arranged in two rows of four each. Beyond these come the slender, long bones of the

hand and fingers, of which no further detailed account is needed.

The hip-girdle or pelvic girdle is a very important structure, as it carries on it, so to speak, the whole of the body save the lower limbs. It is composed of two halves, each named the os innominatum, which join together in front, and behind are united by the wedge of the sacrum (fig. 56). On each side of the hip-girdle is a deep socket, and here the hip-joint is formed by the articulation of the powerful thigh-bone or femur. It is this joint that is apt to be attacked by tubercular disease in children, giving rise to hip-joint disease. The thigh-bone inclines somewhat inwards from the hip as it descends, and forms at its lower end the very important knee-joint by resting on the upper end of the shin-bone. In front of this joint is a small oval bone, the knee-cap or patella. The leg-bones are two in number, that lying to the inner side and front being the shorter and stronger of the two. It is the shin-bone or tibia. To the outer side lies the slender splint-bone or fibula. These two bones at these lower ends form the powerful ankle-joint by articulating with the ankle-bones (tarsus), of which there are seven. Beyond them come the longer bones of the middle of the foot and the toes. These bones form the arch of the foot (see fig. 46), and give spring and elasticity to the movements of the body.

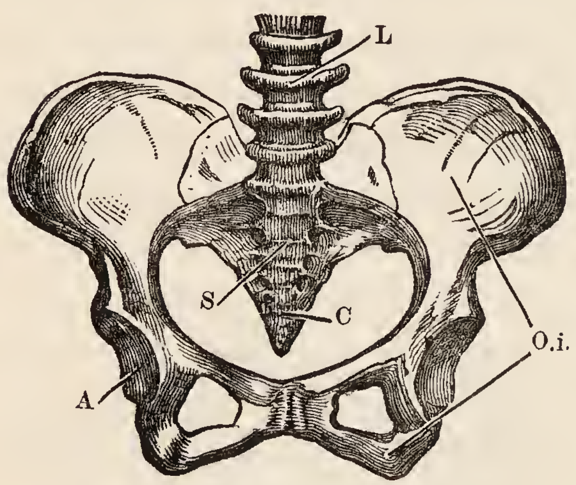


Fig. 56.—The Pelvic Bones

L, Lumbar vertebræ; S, sacrum; C, coccyx; O. i., os innominatum; A, acetabulum.

The description of the skeleton given above is brief, but it is made intentionally so, our aim being merely to run over the general features of the framework of the body with special reference to the physical exercises in use at schools. Before passing on to the consideration of these exercises, it may be mentioned that there are some 200 separate bones in the

adult skeleton, but more than that number in the child's—some of the bones in the latter becoming fused to form a single bone in the adult. Bones consist of organic or animal tissue, and of mineral matter; the former confers toughness and elasticity on the bone, and the latter rigidity. In children the bones contain relatively more animal matter and less mineral substance than in adult life. They are therefore more flexible and less brittle. This very flexibility renders them all the more easily distorted if undue pressure be put upon them, as when a child persistently assumes a bad attitude. The bones of children, too, are growing in length. This growth takes place, not in the centre of the bone, but at, or rather near, its ends. It has already been stated that as muscles are attached to bones, increase in the size and extent of the former leads to increase in size and strength of the latter. Taking any given muscle in relation to any two bones between which it passes, we use the term "origin" for the attachment of the muscle to the bone from which it may be said to spring, and the term "insertion" for the attachment to the bone where it ends. If the muscle can move the first bone towards the second, and the second towards the first with equal facility, the origin for the time being is from the bone which in the movement is kept fixed. For example, in the case of the biceps muscle the shoulder and upper arm are usually kept steady while it performs its ordinary task of bending the elbow-joint and raising the forearm. We say, then, that the biceps takes origin from the shoulder and top of the arm, and is inserted into the forearm. But if the muscle is used by a boy in climbing a rope, the forearm is kept fixed, and the contraction of the muscle draws the shoulder upwards by a bending of the elbow-joint, and so raises the body. In this case its point of origin may be said to be the forearm, its insertion the shoulder.

It is not intended here to give a full and detailed account of the muscles of the body any more than of the bones; and the Physical Code is so full, so explicit, and so well thought out, that it would be superfluous to enter into a discussion of

individual exercises. It does, however, appear to the writer to be important that the teacher should have a slightly detailed knowledge of the great muscles of the back, chest, and trunk, those muscles which are put into action by all general movements, and which are specially employed in breathing exercises.

The Muscles of the Back

The muscles in the back are arranged in several layers or strata, and are somewhat numerous. Those of leading importance will be described.

(*a*) *Erector spinæ*, or erector of the spine, lies deep in the back, close to the spine and ribs. It arises from the back of the hip-bones and sacrum, and runs upwards in

Fig. 57

Fig. 58

numerous subdivisions to be attached to the various vertebræ and ribs, and eventually to the back of the skull.

Action.—It keeps the back straight and erect, raises it from a stooping position, and can even bend the spine backwards (figs. 57 and 58). It keeps the head and neck erect and steady. The muscles on one side acting alone bend the spine to that side. This long muscle is employed in all bending exercises.

(*b*) Somewhat nearer the surface than this, is a stout liga-

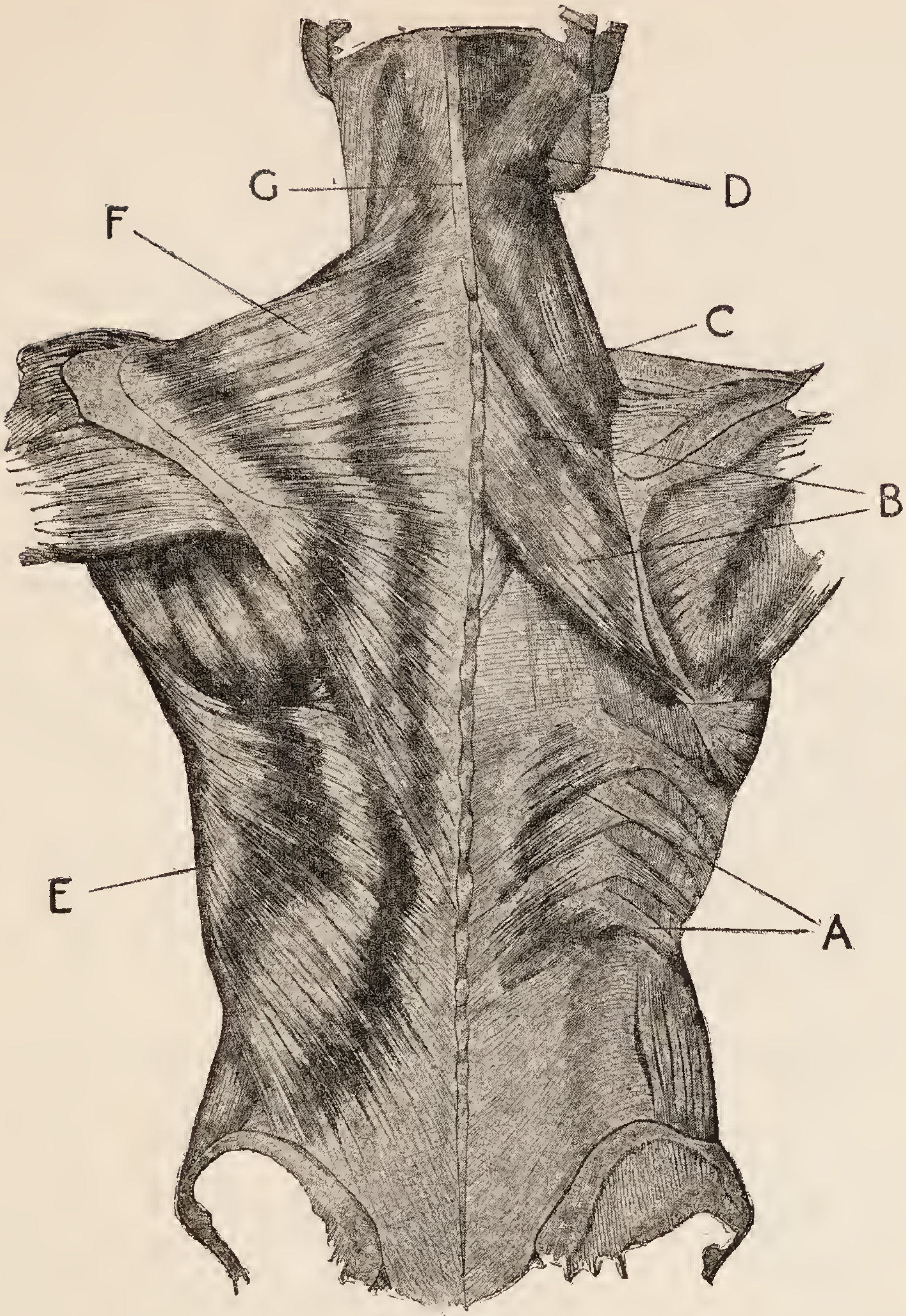


Fig. 59.—Muscles of Back, two layers, the more superficial being on the left side (after Gray)

A, Lesser inferior serrated muscle (*serratus posticus inferior*); B, rhomboid muscles; C, elevator of angle of scapula; D, splenius; E, very broad muscle of back (*latissimus dorsi*); F, trapezius; G, ligament of neck (*ligamentum nuchœ*).

ment or sinew, the *ligamentum nuchœ*, or ligament of the neck. It runs between the back of the head (occiput) and the seventh vertebra of the cervical or neck region (fig. 59, G).

Action.—It helps to support the head.

(*c*) Nearer the surface still, in the lower part of the back, is a muscle divided into four divisions or serrations, and as it is

low in the back it is named by anatomists the *serratus posticus inferior* (fig. 59, A). It takes origin from the last two vertebræ of the dorsal part of the spine and the first two lumbar vertebræ, and is inserted into the last four ribs.

Action.—It pulls these ribs down, and so diminishes chest capacity. It thus acts as an additional aid in forced expiration, and is brought into play in deep-breathing exercises.

(*d*) Higher in the back will be noticed two elongated four-sided muscles, called from their shape the *rhomboideus major* and *minor*—the greater and lesser rhomboid muscles. They take origin from the lower cervical and upper dorsal vertebræ, and are inserted on to the margin of the shoulder-blade next the spine. Above them lies a long, slender muscle—the *Levator anguli scapulæ*, or lifter of the angle of the scapula, which extends from the cervical vertebræ to the upper inner angle of the shoulder-blade (fig. 59, B, C).

Fig. 60

Action.—The last-named helps to draw the shoulder-blade directly upwards. Acting with the two rhomboids it is employed in shrugging the shoulders. The rhomboids acting alone draw the scapulæ backwards, and help to expand the chest. They are used in movements where the chest is thrown out and the upper part of the spine straightened (fig. 60).

(*e*) Above these muscles will be noticed one of short length but distinctly broad. This is named the *splenius*, and runs from the vertebral column in the neck region to be inserted on to the back and the side of the skull (fig. 59, D).

Action.—The two muscles acting in unison help to keep the head erect, or even to draw it back (fig. 61). Either acting alone inclines the head to its own side and rotates it slightly, so that the face is brought round towards the

same shoulder (fig. 62). They are used in head-bending exercises.

(*f*) *The Latissimus dorsi*, or very broad muscle of the back, forms the lower of the two great superficial muscles of the back (fig. 59, E). It is a broad and powerful muscle, and takes origin by an extensive attachment to the crest of the hip-bone, the sacrum, the vertebræ of the loins, and the six lower dorsal

Fig. 61

Fig. 62

Fig. 63

vertebræ. The fibres converge, to end in a powerful, broad tendon inserted into the humerus or upper arm-bone in its upper third.

Action.—This strong muscle, when it acts from below, pulls the upper arm backwards and downwards, with an inward rotation (fig. 63). If the arm, however, be the fixed point, the lower fibres raise the lower ribs, and can in this way aid forced inspiration. With the arms fixed, both muscles together help to pull the trunk forward and upward as in climbing, or forwards as in walking on crutches. It is

employed in arm exercises, in deep breathing, and in many gymnastic feats.

(*g*) *The Trapezius.*—This powerful muscle occupies a large portion of the upper and middle of the back, and forms with its neighbour of the opposite side a diamond-shaped space, hence its name. Each muscle alone is therefore triangular. Its base of origin is very wide, including the occiput, the ligament of the neck (see p. 217), and all the dorsal vertebræ. It is inserted into the outer third of the collar-bone, and into a ridge of bone which crosses the back of the shoulder-blade (fig. 59, F).

Action.—If the head be fixed, the upper fibres lift the shoulder, while the middle and lower parts of the muscle rotate back the scapulæ. It acts like the splenius and rhomboids combined, but more powerfully. With the shoulders fixed, both muscles in concert draw the head back; one acting by itself pulls it towards its own side (figs. 61 and 62). This muscle, along with the latissimus dorsi, is of great importance in all exercises of the shoulders, upper arm, and upper part of the trunk.

The Muscles of the Front and Sides of the Chest

The front of the chest and top of the shoulder are covered by muscles of considerable size and power, of which the most important are the following:—

(*a*) *The Pectoralis Major*, or greater chest muscle, forms the chief mass of muscle on the front of the chest. It takes origin from the inner half of the collar-bone, from the breast-bone, and from the gristle parts of the first six ribs. It is inserted on to the neck of the upper-arm bone. It is not shown in fig. 64, but its cut edge is seen attached to the breast-bone and collar-bone, and its divided tendon. It forms a big mass of muscle, roughly triangular in shape, the apex of the triangle being at the arm-bone.

Action.—When the chest is the fixed point, this muscle depresses the raised arm, and can pull it in across the chest

(fig. 63). If the arm be fixed, the muscle draws out the upper ribs, and so aids deep inspiration. If the arms are fixed, but higher than the head, as in climbing a rope, the greater pectoral helps to pull up the body. This muscle is used in many gymnastic feats, and is greatly developed by swimming.

(*b*) *The Pectoralis Minor*, or lesser pectoral muscle, lies below

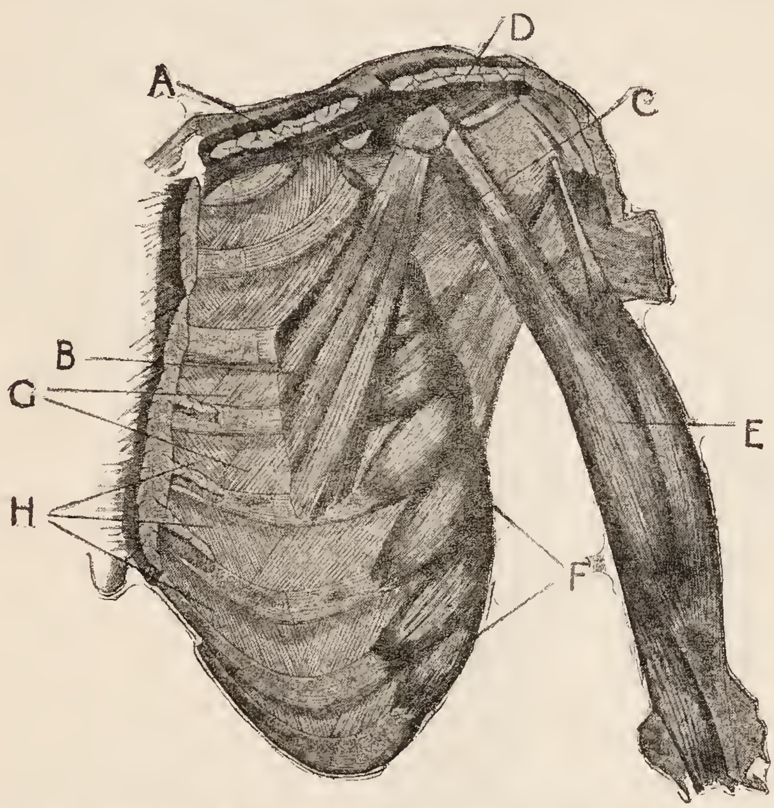


Fig. 64.—Muscles of Front of Chest and Shoulder (after Gray)

A, Cut portion of greater chest muscle (*pectoralis major*); B, lesser chest muscle (*pectoralis minor*); C, subscapular muscle; D, deltoid muscle; E, biceps; F, greater serrated muscle (*serratus magnus*); G, external intercostal muscles; H, internal intercostal muscles.

its big brother (fig. 64, B). It forms an elongated triangle, and runs from the third, fourth, and fifth ribs to the tip of the shoulder-blade.

Action. — This muscle acting from the chest draws the shoulder downwards and inwards. If the shoulders are kept fixed, the ribs to which it is attached are pulled a little outwards, and the chest capacity is thus increased. It acts, therefore, as an accessory muscle in deep breathing. It, too, is employed in swimming.

(*c*) The *subscapular* muscle lies, as its name indicates, under cover of the scapula or shoulder-blade. It is a large triangular muscle of considerable power. It is seen in fig. 64 passing across from the chest wall to the upper-arm bone. It arises from the under-surface of the shoulder-blade, and is attached by a strong tendon to a knob of bone near the head of the upper-arm bone.

Action.—It rotates the humerus or upper-arm bone inwards, and helps to depress it when raised. If the arms are

Fig. 65

Fig. 66

fixed above the head, this muscle helps to draw up the trunk, as in climbing.

(*d*) *The Deltoid*, so called from its supposed resemblance to the Greek capital Δ (delta), is a fleshy, triangular muscle which covers the point of the shoulder. Its cut edge is seen in fig. 64, where it takes origin from the outer third of the collar-bone, and the spine and tip of the shoulder-blade. Its fibres converge to be inserted into the outer surface of the humerus

near its upper third. The fleshy mass is sometimes subdivided into a front and back portion.

Action.—It raises the arm directly from the side (fig. 66). Once raised, the front part of the muscle acting with the greater and lesser pectorals pull the arm forward (fig. 67). The hind part, in conjunction with the latissimus dorsi, can pull it backwards. This muscle is used in all arm-raising exercises, and is greatly benefited in strength by swimming.

Fig. 67

(*e*) *The Biceps.*—On the front of the upper arm is a long, fleshy mass of muscle, well known to all. It is indeed the pride of every boy to have a well-developed biceps. It is somewhat split above, so that it takes origin by two tendons from the point of the shoulder-blade (fig. 64, E), and it is inserted on to a knob of bone near the neck of the radius, the outer of the two forearm bones.

Action.—It has a powerful action in bending the forearm (cf. fig. 37), and can also supinate it to some extent. If the forearm be fixed, and the muscle act from this point, it approximates the upper arm to the forearm, and draws the body up as in climbing. It is greatly increased in size by rowing.

(*f*) *The Triceps* receives this name because it has three heads or tendons of origin, attached to the shoulder-blade and the humerus. It is a long muscle lying at the back of the upper arm, and is inserted on to the back aspect of the top of the ulna, the inner of the forearm bones (cf. fig. 52).

Action.—It is antagonistic to the biceps, and extends the forearm when bent.

Muscles of the Chest Wall acting specially on the Ribs

(*a*) *The Serratus Magnus* is a large muscle lying on the side of the chest. It is so called because of its size, and because it is subdivided into a number of slips or serrations (fig. 64, F). It takes origin by these slips from the eight upper ribs, and is attached to the under-surface of the shoulder-blade at its inner border (the border next the spine). (See also fig. 68.)

Action.—This is a powerful aid to deep inspiration. The shoulder is kept fixed, and the muscle acting from that point pulls the eight upper ribs outwards, and so increases the chest capacity. If the ribs are kept steady and the breath is held, the muscle pulls the shoulder-blade forwards and tilts it up a little, and with the aid of the trapezius braces up the shoulder in carrying heavy weights.

(*b*) *The External Intercostals.*—The Latin name for a rib being *costa*, it is at once clear that these muscles lie between ribs and form an outer layer. There are eleven pairs, and their short fibres run between the lower edge of every rib (except the last) and the upper edge of the rib just below it. These fibres are directed downwards and forwards (fig. 64, G). The muscle extends from near the end of the rib attached to the spine, as far forward as where the gristle of the rib begins.

Action.—These muscles are employed in ordinary inspiration. They raise the ribs (especially their front portions), and so increase the chest capacity.

(*c*) *The Internal Intercostals.*—These muscles (also eleven pairs) are antagonistic to those just described. They commence as far forwards as the breast-bone, and end at the angles of the ribs. The fibres run from any given rib (except the last) to the upper border of the rib below, but have a direction downwards and *backwards* (fig. 64, H).

Action.—Over the greater part of their course these muscles depress and invert the ribs, lessening chest capacity. They are therefore used in ordinary expiration. The very front part of the muscle, however—that lying between the gristle

portions of the ribs—aids the external intercostals to raise the ribs.

(*d*) Besides those named, there are twelve pairs of short muscles near the spinal column whose function it is to raise the ribs near this point. They are therefore called the *Levatores costarum*, or elevators of the ribs. They run in pairs from each dorsal vertebra to the rib immediately below, and by lifting the ribs help the external intercostals in inspiration; they are thus of use in ordinary breathing.

Muscles of the Abdomen

A glance at the figure of the skeleton shows that the lower part of the trunk (below the ribs) has no bone in front to serve as a support or protection to the important organs contained in the abdomen or belly. This deficiency of bone is made up for by very strong broad muscles, of which a short account must be given. Two of these muscles have fibres running obliquely, one has fibres running horizontally or transversely, and one has a vertical course.

(*a*) *The External Oblique Muscle* is the outermost of the muscles, and forms a great sheet running from above downwards and forwards. It is attached above to the eight lower ribs, and below to the crest and front of the hip-bone, while in front it interlaces with its neighbour of the opposite side (fig. 68, A). Its action will be described along with that of the other muscles of this part.

(*b*) *The Internal Oblique Muscle* forms a layer below that just described, and runs from above downwards and backwards. It is attached in front to a broad, tendinous band running from the middle and front of the hip-bone to the breast-bone, and also has attachment below to the crest of the hip-bone, while above it is fastened to the four lower ribs.

(*c*) *The Transversalis Muscle*, as its name implies, runs crossways, and lies beneath the internal oblique. It is attached below to the hip-bone, in the middle line to the same strong tendinous band as the preceding muscle, and above to the six lower ribs.

(*d*) *The Rectus Muscle* cannot be anything but upright, and accordingly runs from the front of the hip-bone as a straight, fairly broad band of fibres, to be attached to the gristle

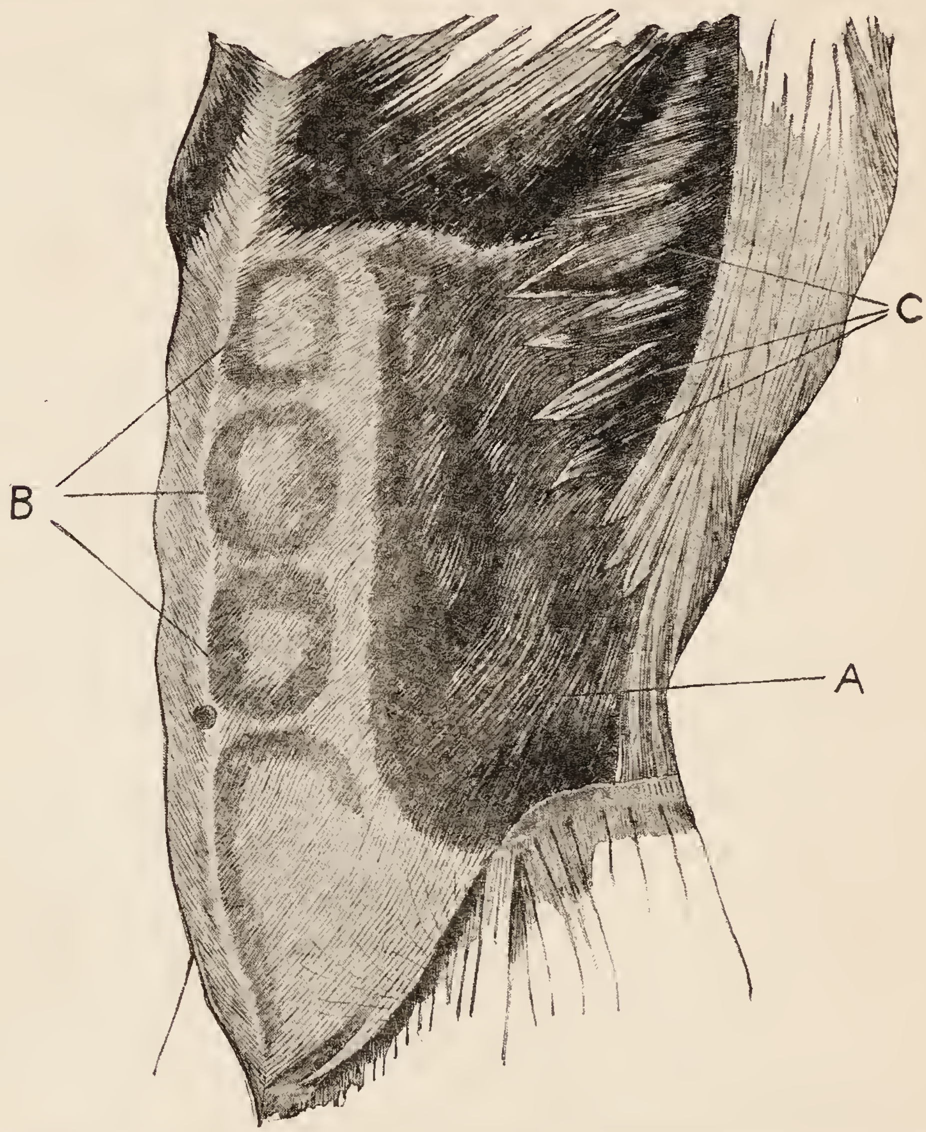


Fig. 68.—Muscles of Wall of Abdomen and Lower Part of Chest (after Gray)

A, External oblique muscle; B, rectus muscle; C, great serratus muscle. In the chest is seen the lower half of the greater pectoral muscle.

portions of the fifth, sixth, and seventh ribs of its own side (fig. 68, B).

Action of the Abdominal Muscles.—These powerful muscles, four on each side, act as a valuable wall of protection to the organs of the abdomen. They can be made very rigid and tense, and can resist a severe blow. They gain much strength from the fact that their fibres run in different directions, and

from their being arranged in three distinct planes or strata. Their special actions are as follows:—

1. If the hip-girdle and chest are fixed, they powerfully compress the internal organs. They are thus made use of in coughing, when the stomach empties itself by sickness, when the bowels move, and in other important physiological acts.

Fig. 69

Fig. 70

2. If the spine is kept fixed, they can compress the lower part of the chest and slightly bend it forwards. In this way they act as expiratory muscles.

3. If the hips are fixed, they bend the spine and draw down the chest. They thus bend the body forwards and aid expiration (fig. 69).

4. If the thorax is fixed, they pull up the hips (and so the lower part of the body), as in climbing.

5. When the muscles act on one side only, they bend the chest towards that side (fig. 70).

The Diaphragm

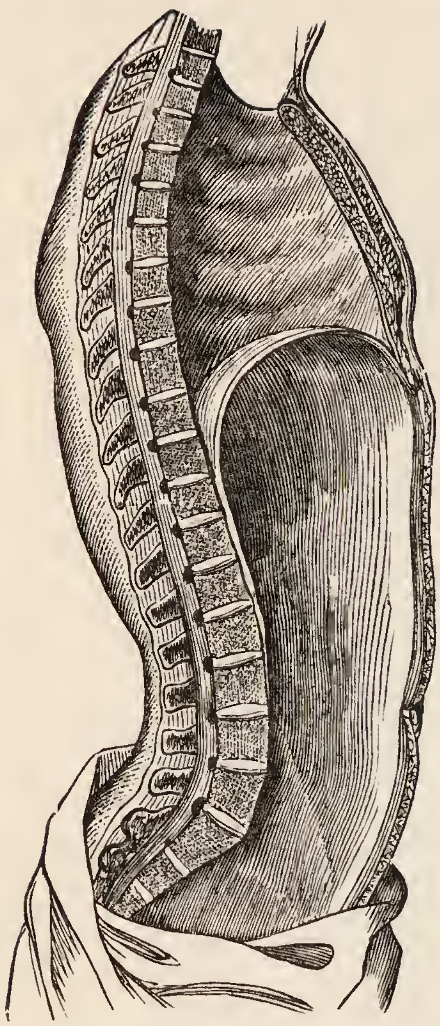


Fig. 71.—The Diaphragm

No account of the abdominal muscles would be complete without a reference to the *Diaphragm*, the great dome-shaped muscular partition which separates the chest from the abdomen (fig. 71). It is attached all round the body to the following points: the inner surface of the tip of the breast-bone, the inner surface of the six or seven lower ribs, and to the vertebræ of the loins or lumbar region. Its fibres run in to be united at the top of its dome into a central tendinous mass.

Action.—When it contracts it flattens, and so increases the vertical height of the thorax. This increases the chest capacity, and so the diaphragm acts as one of the most important muscles of inspiration. As it flattens it also compresses the organs of the trunk. When the diaphragm relaxes, it rises, becomes more dome-like, and expels air from the lungs. It then acts as a muscle of expiration.

The Lower Limbs

Details regarding the muscles of the lower limbs will not be given, but a few lines may be spared for a word or two on the leading groups of muscles of the thigh and leg. The mass of the hip is made up of powerful muscles running a short course from the hip-bone to the thigh-bone. These muscles straighten the thigh on the body at the hip-joint, are used to pull back the leg in walking, and are employed in raising the body from a stooping to an erect posture; they are much strengthened

by walking and wrestling. Similar muscles, not quite so large or powerful, pass from the inner side of the hip-bone to the front of the thigh-bone, and move the thigh forward in walking, and bend it on the trunk at the hip-joint.

The front of the thigh is covered by large fleshy muscles, which unite into a common tendon. This, at the front of the knee, is attached to the little bone we call the knee-cap, and from this again a short tendon stretches to be fastened to the front of the shin-bone near its upper end. For all practical purposes we may say that the common tendon of the great muscles of the front of the thigh is attached to the upper end of the shin-bone, passing over the front of the knee-joint.

These powerful muscles straighten the leg on the thigh at the knee-joint. They are used much in walking, running, and kicking. If the leg is fixed, the muscles act from below and balance the thigh-bone on the shin-bone, helping to keep the body erect and to prevent it swaying backwards. Its action is opposed by a large muscle on the back of the thigh (the biceps of the lower limb) which runs from the hip-bone to the upper part of both the shin- and the splint-bone on their hinder aspect. This long muscle when it contracts, bends the leg at the knee-joint. If the leg is fixed, the muscle helps to balance the body, and keeps it from toppling over. At the inner side of each thigh there is a further group of muscles, called *Adductors*, because their action is to draw the thighs together. They are greatly used by men or boys who ride on horseback, as they help the rider to keep his seat by the inward pressure of the thighs.

There are numerous other smaller muscles of the thigh and leg which need not be specified in detail, but a few words must be said about the fleshy mass at the back of the leg and its great tendon. In fig. 47, this collection of muscles of the calf is seen. The muscles are attached above, partly to the lower end of the thigh-bone behind, partly to the back of the leg-bones. The muscular mass ends in a very strong tendon —the Tendo Achilles—which is attached to the back of the heel-bone. This tendon is, for its size, remarkable for its

combined strength and elasticity, and is very constantly made use of. Acting from above, it raises the heel off the ground and straightens the foot on the leg (fig. 72). It is thus used constantly in walking, jumping, and dancing, and these exercises greatly increase the size and strength of the muscles on the back of the calf. If the foot is kept fixed below, this strong tendon helps to balance the body at the ankle-joint and to prevent it toppling forward.

Fig. 72

We have now considered the chief individual muscles and their actions. Let us, in conclusion, consider certain special movements, and see what muscles are employed in their performance.

1. *Inspiration.* (*a*) *Tranquil.*—The external intercostals, the front part of the internal intercostals, the elevators of the ribs, and the diaphragm by its flattening or descent. (*b*) *Deep.*—Same muscles, with in addition the greater and smaller pectorals, the large serrated muscle, the trapezius, and (if the arms be fixed) the latissimus dorsi.

2. *Expiration.* (*a*) *Tranquil.*—The part of the internal intercostals behind the gristle of the ribs, and the diaphragm in its rise. These are aided by the elastic recoil of the chest walls. (*b*) *Forced.*—The same muscles, with in addition the abdominal muscles, the lower serrated muscle (behind), and the muscles of the loins.

3. *Shoulder pulled back.* Trapezius and the two rhomboids.

4. *Shoulder raised.* Trapezius and the levator anguli scapulæ.

5. *Shoulder drawn forward and steadied for weight-carrying.* Trapezius and serratus magnus.

6. *Arm raised.* Deltoid.

7. *Arm depressed.* Great pectoral muscle and subscapular.

8. *Arm drawn in across chest.* Pectoralis major and front part of deltoid.

9. *Arm pulled back.* Latissimus dorsi and back part of deltoid.

10. *Head drawn back.* Splenius and trapezius.

11. *Trunk pulled up and forward.* Latissimus dorsi chiefly.

12. *Trunk raised (as in climbing).* Biceps of arms, and abdominal muscles.

13. *Chest bent forward.* Abdominal muscles.

14. *Body straightened, and back kept erect.* Hip-muscles and long muscles for erecting the spine.

15. *Thigh and leg thrown forward (as in walking).* Muscles of front of hip and thigh.

16. *Thigh drawn back.* Great muscles of hip (back).

17. *Body raised on heel.* Muscles of the calf acting through the tendon of Achilles.

Well-planned exercises aim at the systematic employment of all these muscles, and so promote a harmonious development of the body in all its parts. No teacher is expected to commit the names of the muscles to memory; but by a reference to the table given above it will be seen at once what principal muscles are employed in any given movement, and by reference to the anatomical description preceding, the teacher will see what particular bones and joints are involved. It is by careful study of this kind that rational (and therefore successful) correction for deformity and bodily weakness can be carried out.

CHAPTER XV

Corporal Punishment in Schools

Corporal Punishment in Schools.—The writer considers it wise to say a few words in conclusion on this important subject, on account of the intimate relationship existing between it and the health of the child. If children are to be taught in accordance with the best views of hygiene, they should be punished in a similar way. No brief is held by the

writer for or against corporal chastisement; it is presumed that it is to continue in use, otherwise the *raison d'être* for this short chapter would disappear. With its continuance we must take care that no evils accompany it.

Corporal punishment is the infliction of pain on the person of the culprit, to act as a deterrent against repetition of the act for which he was punished, or of similar acts. The aim should be to inflict a sufficiency of pain, especially of pain that rapidly reaches a maximum, and disappears not too fast, and yet to do no physical injury of any kind to the child. If corporal punishment is used, let it be effectual, but let it at no time verge on brutality. There is a considerable tendency on the part of the public to raise an outcry against corporal punishment, so that it behooves those who have to administer it to see that no cause of offence is offered. The question, as far as we are concerned, resolves itself into two parts: (1) what parts of the body should be selected, what parts avoided, for the infliction of chastisement? and (2) what instrument should be employed?

Regions of the Body on which Punishment may and may not be inflicted

(*a*) *The Head.*—This should never be selected as the site for punishment. It is of all parts that most susceptible to injury in the child. The practice of pulling and boxing the ears has been already referred to (see pp. 19, 151). Pulling the ears gives them a bad shape at the least, and may easily lead to swelling of the ear-lobe and to bleeding under the skin. Boxing the ears can produce the same effect on the external ear, and in addition may damage the delicate mechanism of the inner ear, leading to deafness, or may set up inflammation of the membranes of the brain in this region. Other parts of the head are equally sensitive in the child, and a sharp knock on the skull may lead to bleeding over the surface of the brain and to grave consequences. The face is also to be avoided, as the soft tissues here are readily bruised

and even cut. It may happen that a slap of very moderate severity may produce marked effects on the delicate tissues of a young child, and the condition may look much worse than it really is. Teachers should be careful to avoid any cause for complaint in this respect.

(*b*) *The Hands.*—These are frequently selected as suitable and accessible for the infliction of the cane or tawse, or even of slaps by the teacher's own hand in the case of very young children. The hand consists of numerous small slender bones (cf. fig. 53), articulated together to form the palm and fingers, and has traversing its length many slender tendons whose function is to bend the fingers. It thus contains a good many structures susceptible of injury, and in the writer's opinion should not be struck with hard or rigid implements, such as canes and rulers. These can easily damage the articular ends of the slender finger bones where they form the joints, and can also hurt the tendons, leading to inflammation and thickening. Such disabilities do not attach to the use of the tawse, which is simply a short, broad, fairly-thick strap of leather, some 15 × 3 inches, and divided into four or five slips at one end. The sensation produced by this instrument is sufficiently painful, yet from its flexibility it does not strain or harm the deeper parts. In the case of young children no harm can result from one or two sharp slaps on the palm administered by means of the teacher's own hand.

(*c*) *The Back.*—This part of the human frame presents itself so readily that one is much tempted to chastise a naughty child by slaps, knocks, or stripes, with a cane, pointer, or ruler, across the shoulders. This is not to be commended at all—indeed one might go further with advantage and say that children should never be struck on the back for fear of spinal injury ensuing. The skin here is not very sensitive, it is covered with clothing, and to produce any appreciable smarting a good deal of force may require to be employed, which, while it does not affect the skin much, may injure the spine lying below it. The back, therefore, should not be selected.

(*d*) *The Hips.*—Not a few writers on school-management

assert that this is the ideal part of the body to bear stripes, and that it seems almost as if designed by Providence for this among other functions. It is, of course, only used in the case of boys. The skin is reasonably sensitive, and below it in the child is usually a good layer of fat, covering the cushion of muscles which pass to the upper and back part of the thigh-bone (see p. 228). Below all is the strong pelvic girdle. There is little here that can be hurt by reasonable severity, and in addition we have the element of humiliation entering into punishment on this part. Chastisement of this kind should be done only by the headmaster, and the culprit must be made to bend to render the nether garments tight, or the latter may be slipped down altogether. In the case of the very young the hand is employed as the instrument in the domestic circle; in the case of boys at school the old-fashioned "birch" may be used, or the tawse. This may certainly be regarded as one of the safest parts of the body for corporal punishment.

(*e*) *The Legs.*—The writer well remembers a drill-instructor, in his youthful days, who constantly punished idle or inattentive boys by striking them sharply over the shins with a stout stick. This form of punishment cannot be approved. Blows with sticks, canes, or rulers on the legs, or kicks in the same quarter, may cause injury to the knee-joint, or to the shin-bone, which, as everyone is aware, lies very near the surface here. The covering of the bone (*periosteum*) may be damaged, and inflammation of the same result (*periostitis*), with perhaps sloughing of portions of bone. The legs, like the back, are not very sensitive on the skin, and a good deal of force may be applied without the boy feeling it apparently at the time, unless the blow be over the sharp shin-bone.

(*f*) *The Arms.*—What has been said of the legs applies in general with equal force to the arms. There is one special form of punishment (shall I call it?) which is sometimes applied to the arm, and to it alone, and that is "twisting the arm", that form of school-boy torture in which the arm is drawn behind the back and then rotated by a grasp of the wrist till

great pain is felt at the shoulder-joint. This cruel form of chastisement should never be employed. There is no doubt that it has been used in the past, and there is great danger of its setting up inflammation of the shoulder-joint. Boys, moreover, should be deterred from practising it on one another.

The Instrument to be employed in Chastisement

This has to some extent been indicated already. The cane, ruler, pointer, or stick should be used nowhere on the body. On the hand especially, such an instrument is capable of causing deep-seated bruises and lacerations. Even on the hips their use is to be deprecated. The hands of the teacher are suitable for infliction of mild corporal punishment on little children. The "birch", consisting of a bundle of slender branches of the common birch or some similar tree, has an honourable tradition as an implement of chastisement, especially in England. There is much to be said in its favour, as it causes much smarting and pain, but is unlikely, on account of the flexible character of the component twigs, to do harm to structures under the skin. Dr. Clement Dukes, of Rugby, in his *Health at School* (4th edit., 1905), says: "I approve of the use of the 'birch' only, for it simply temporarily stings, and neither damages the skin nor the subjacent structures. It should be administered only on the place suggested by nature; and thus applied, I continue to advocate it, as one of the kindest, most impressive, and least injurious punishments. Further, it should be invariably administered by the headmaster, or in his presence, after a written report of the offence, and never by the 'form-master'."

The tawse is an implement of chastisement very largely used in Scotland. The curious will not find the word in *Chambers's Dictionary*, but its origin is clearly indicated by the verb *taw*, which is defined as meaning to "prepare and dress, as skins into white leather". *The Imperial Dictionary* gives the word, defining it as "a leather strap usually with a slit or fringe-like end, used as an instrument of chastisement by schoolmasters

and others". It consists, as mentioned above, of a broad piece of leather, one of whose ends is split up into four or five strips. It is very largely—indeed almost universally—employed in primary and secondary (day) schools north of the border, and the writer as a boy had a very extensive experience of it. He cannot recollect any instance, either in his own experience or that of others, in which injury resulted from its use when applied to the hands. It is the only means of corporal correction countenanced by the School Board of Glasgow, and they insist, very properly, that a regulation tawse shall be employed, made of definite pattern and weight. Uniformity is thus obtained, and justice so far dispensed impartially. It is not permitted to harden the ends of the strap by burning or other means, a practice once in vogue to make it a more formidable means of punishment. It is this kind of hardening of the leather that makes the tawse a possible means of injury; if used with the leather moderately flexible it cannot act harmfully. The writer has never known of a case where its application did any harm to the hand or person of the culprit. It is usually applied to the hands, though in young boys the hind-quarters are quite suitable. It may be used on the hands as a convenient punishment for girls too, though, fortunately, they require corporal punishment much less than boys.

It was stated at the beginning of this chapter that all that was to be considered here was the effect of corporal punishment on the bodily frame of the child. No discussion of the necessity, value, or otherwise of this form of punishment was intended. But the writer would like to say, in conclusion, that he agrees with Dr. Dukes that corporal punishment should not be used for inattention, unpunctuality, or idling in class, if it can possibly be helped; but should be restricted to such grave faults as lying, thieving, and immorality, and repeated bullying and brutality.

INDEX